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ATTORNEY DOCKET NUMBER 3400P012

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO (If known, see 37 CFR 1.5) 10/031243

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/03540	April 18, 2000	April 19, 1999

TITLE OF INVENTION
SITUATION-DEPENDENT OPERATING SEMANTIC N-ORDER NETWORK

APPLICANT(S) FOR DO/EO/US
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Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b)) and PCT articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4))
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A subsequent specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:

priority request; formal drawings transmittal; PCT-A-Publication A2, PCT-A-Publication-A3; PCT request; IB 304, 308, 332 and 306, International Preliminary Examination Report including amended sheets (in German language); English translation of the documents as amended during international preliminary examination; copy of complete application (31 pages)

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/031243	PCT/EP00/03540	3400P012

17. ☒ The following fees are submitted:

	CALCULATIONS	FOR PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482 nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by EPO or JPO **$1040.00**		
International preliminary examination fee (37CFR1.482)not paid to USPTO but International Search Report prepared by the EPO or JPO.... **$890.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee paid to USPTO (37 CFR 1.445(a)(2)) **$740.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
International preliminary examination fee paid to USPTO (37 CFR 1 482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE		
Total claims	25	- 20 =	5	X **$18.00**	$ 90.00	
Independent claims	1	- 3 =	0	X **$84.00**	$ 0.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+ **$280.00**	$ 280.00	
TOTAL OF ABOVE CALCULATIONS =					$ 1260.00	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also by filed (Note 37 CFR 1.9, 1.27, 1 28)					$	
SUBTOTAL =					$ 1260.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +					$	
TOTAL NATIONAL FEE =					$ 1260.00	
Fee for recording the enclosed assignment (37 CFR 1 21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3 31). **$40.00** per property +					$	
TOTAL FEES ENCLOSED =					$ 1260.00	
					$ **Amount to be: refunded**	$
					charged	$

a. ☒ A check in the amount of $ 1260.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ____________ in the amount of $______________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 022666 . A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

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30,139
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5/PRTS

Description

n^{th}-order Semantic Network Allowing for Situation-dependent Operation

The present invention relates to an n^{th}-order semantic network in accordance with the preamble of claim 1 and in particular a semantic network of this type in which operating within the semantic network is performed in dependence on a respective situation existing in the semantic network.

In the prior art, the term of an "emotional agent" is known in the fields of "artificial intelligence" and "artificial life".

According to the technical literature "*Künstliches Leben, Anspruch und Wirklichkeit*" [≈ Artificial Life, Claim and Reality] by Werner Kinnebrock, 1996, Oldenbourg, ISBN 3486234854, such an emotional agent has the following properties:

a) the agent acts in environments,
b) the agent has a plan of action,
c) the agent is autonomous,
d) the agent has its own memory area or may access memory areas intended for all agents,
e) the agent may assume a defined, specific task within an agent system,
f) the agent possesses learning ability which may be supported or made possible through neuronal networks,
g) the agent has assessment mechanisms,
h) the agent may exhibit a dynamic adaptive behavior, and

i) the agent may possess and exhibit emotions which influence the agent's behavior and are influenced by this behavior.

Such agent systems including agents may be structured hierarchically or operate with distributed control. Here the emotions merely represent moods which are "carried along" when operating in the agent system and thus influence operation within the agent system.

In brief, the above mentioned technical literature describes behavior-based systems which intelligently process information and in addition act in an artificial or real environment such as to solve defined tasks with a maximum degree of success. Evolutionary development and individual learning are two ways in which these systems acquire their abilities.

Moreover it has hitherto been known in the prior art to simulate and describe emotions of humans or animals. Mention is made, for example, of agents or computers capable of exhibiting emotions. The purpose pursued in this thus merely is to simulate, to describe and/or to explain man or the animals.

In current network structures there is a problem which is increasingly significant with a higher complexity of the network structure in that when operating on a network structure, for example the performance limits even of modern computers or computer networks are reached or even exceeded, for it is necessary to access all the information within the network structure. In just about any material and immaterial network structures in the prior art it is therefore an essential target to utilize a type of management permitting optimum use of available resources,

e.g. time. Hitherto used approaches for carrying out such a management are, however, rigid or only little flexible as regards the utilized strategy, and accordingly are only conditionally or not at all applicable with an increasing complexity.

In particular the previous approaches are not suited for carrying out a management or only conditionally suited for demand-oriented operation on network structures such as, for example, semantic networks, while considering respective states that exist within the network structure at specific times.

A semantic network in accordance with the preamble of claim 1 is known from LIM E-P et al.: "SEMANTIC NETWORKS AND ASSOCIATIVE DATABASES: TWO APPROACHES TO KNOWLEDGE REPRESENTATION AND REASONING", IEEE Expert, U.S., NY, Vol. 7, No. 4, August 1992, pp. 31 to 40.

It is therefore an object of the present invention to furnish a semantic n^{th}-order network whereby demand-oriented operation within the semantic network in dependence on a situation is possible in a flexible manner.

This object is attained in accordance with the invention through the measures indicated in claim 1.

~~To be more precise, in accordance with the invention a semantic network is furnished which is comprised of a multiplicity of units, with the semantic network having both semantic units possessing relational contents and also linking units which describe a relational content linking two respective semantic units such that the mutual relation of the two semantic units is determined by the relational content. Moreover in this semantic~~

~~network at least some of the semantic units are specific semantic Janus units which are also linked with other semantic units through linking units. These semantic units may carry out operations on themselves, on the semantic units to which they are linked and/or on those to which these in turn are directly or indirectly linked and/or on the linking units of these mentioned semantic units. These semantic Janus units in turn possess states that are variable in time and determine what operations are to be carried out on what semantic units and/or linking units.~~

In the semantic network <u>in accordance with claim 1</u> it is possible, in dependence on a respective situation existing in the semantic network and expressed through the time-variable states of the semantic Janus units, to perform operating within the semantic network, wherein focusing or concentration on selected portions of the semantic network takes place. As a result, these semantic Janus units do not at any time have to deal in detail with all possible informational contents and/or relational contents of semantic units and/or linking units within the semantic network. Resources such as e.g. time, may accordingly be saved in the semantic network, which would otherwise be required for processing within the semantic network.

Focusing on selected parts of the semantic network secures a substantial reduction of knowledge to be processed and of data to be processed, respectively, so that for example a processing speed may be raised drastically on account of the achieved temporal allotment of resources.

~~The semantic Janus units preferably have both a vicinity to be monitored, which is monitored by the~~

~~semantic Janus units, and a vicinity to be shaped on which the semantic Janus units perform operations.~~

~~Moreover a respective new state of a semantic Janus unit may be determined from the existing state of the semantic Janus unit and/or from an analysis of an optionally variable vicinity to be monitored.~~

~~Herein there is a possibility of the respective new state of the semantic Janus unit acting both on the vicinity to be monitored and on the vicinity to be shaped.~~

Further advantageous developments of the present invention are the subject matters of the subclaims.

The present invention shall hereinbelow be explained in more detail by way of an embodiment while referring to the enclosed drawing, wherein:

Figs. 1a to 1e are representations of linking units usable in a semantic network.

Fig. 2 is a representation of an exemplary semantic network;

Fig. 3 shows a sequence of operation for elucidating operation in a semantic network in accordance with an embodiment of the present invention; and

Fig. 4 shows a system of coordinates of affects which is applicable in the embodiment of the present invention.

With regard to the terms "semantic network", "semantic unit" and "linking unit" employed in the instant application, reference is made to ~~the application by the same applicant having serial no.~~ DE 199 08 204.9 ~~and~~ entitled "n^{th}-order fractal network for handling complex structures", ~~deposited on February 25, 1999,~~ wherein the terms of "semantic network" and "fractal network" are to be considered equivalents. ~~The features disclosed in the above mentioned application with respect to the "fractal network", the "semantic unit" and the "linking unit" are deemed included in the instant application by reference, for these are essential features of the present invention.~~

Before describing in detail an embodiment of the present invention in the further course, the structure of an exemplary semantic network shall be outlined for the sake of clarity while referring to Figs. 1a to 1e and 2.

Figures 1a to 1e show representations of linking units that are applicable in a semantic network.

Elementary types of linking units conceivably are exchange relations and relations. Exchange relations are defined as those relations describing an abstract, material and/or communicative exchange between semantic units. Relations, on the other hand, are those relational contents of linking units which describe relations of some kind between semantic units. Figs. 1a to 1e show several such elementary linking units describing a respective relational content.

In the case of hierarchically structured knowledge, such as in the semantic network, linking units of the exchange relation type may be further subdivided into two groups.

What is shown in Fig. 1a is a linking unit 1 of the exchange relation type which interconnects semantic units in mutually different hierarchy levels of the n^{th}-order semantic network. What is thus described is the kind of relation of a larger, i.e., superordinate semantic unit with a smaller, i.e. subordinate semantic unit and vice versa. In other words, a scale change is carried out. Linking units having relations which exhibit the two named features, namely, an exchange and a scale change, are hereinafter designated as linking units of the VA/VS type. In the expression "VA/VS", the term "VA" accordingly represents "exchange", while the term "VS" represents "scale change". In simple terms, a like linking unit 1 of the VA/VS type may be regarded to be "A contains B" in the direction of the arrow from A to B shown in Fig. 1a, and "B is part of A" in the opposite direction. This corresponds to the definition of an embedding hierarchy.

Fig. 1b shows linking units 2, 2a and 2b of the exchange relation type which interconnect semantic units in same hierarchy levels of the n^{th}-order semantic network. In other words, no scale change is performed. Linking units having relations which exhibit the two named features, namely, an exchange and no scale change, are hereinafter designated as linking units of the VA/VH type. In the expression "VA/VH" the term "VA" accordingly represents "exchange", and the term "VH" represents "no scale change". In simple terms, a like linking unit 2a of the VA/VH type may be regarded to be "A is input quantity of B" in the direction from A to B, and "B is output quantity of A" in the opposite direction, and such a linking unit 2b of the VA/VH type may be regarded to be "A is described by B" in the direction from A to B, and "B is attribute of A" in the opposite direction.

In the case of hierarchically structured knowledge, as in the semantic network, linking units of the relation type may be further subdivided into two groups.

Fig. 1c shows a linking unit 3 of the relation type which interconnects semantic units in mutually different hierarchy levels of the n^{th}-order semantic network. What is thus described is the kind of relation of a more general semantic unit with a more specific semantic unit and vice versa. In other words, a scale change is performed. Linking units having relations which exhibit the two mentioned features, namely, a relation and a scale change, are hereinafter referred to as linking units of the VR/VS type. In the expression "VR/VS", the term "VR" accordingly represents "relation", and the term "VS" represents "scale change". In simple terms, a like linking unit 3 of the VR/VS type may be regarded to be "A in particular is B" in the direction of the arrow from A to B shown in Fig. 1c, and "B in general is A" in the opposite direction. This corresponds to the definition of a similarity hierarchy.

Fig. 1d shows linking units 4, 4a, 4b and 4c of the relation type which interconnect semantic units in same hierarchy levels of the n^{th}-order semantic network. In other words, no scale change is performed. Linking units having relations which exhibit the two mentioned features, namely, a relation and no scale change, are hereinafter referred to as linking units of the VR/VH type. In the expression "VR/VH", the term "VR" accordingly represents "relation", and the term "VH" represents "no scale change". In simple terms, a like linking unit 4a of the VR/VH type may be regarded to be "A is (locally) adjacent B", a like linking unit 4b of the VR/VH type may be regarded to be "A is similar to B",

and a like linking unit 4c of the VR/VH type in the direction from A to B may be regarded to be "B follows after A" in the direction from A to B and "A is followed by B" in the opposite direction.

Fig. 1e moreover shows another linking unit 5 which may be regarded to be "A has Janus/function B" in the direction from A to B and "B is Janus/function of A" in the opposite direction. With respect to a more detailed description of this linking unit 5, reference is made to the detailed description of the embodiment further below.

It should be noted here that besides the above mentioned types of linking units, any types of linking units may generally be freely selected by a user. It is, however, sensible to define several elementary types of linking units in advance in a basic library.

Finally it should be noted that evidently linking units may both be directional, i.e., directed, and bidirectional, i.e., non-directional.

Reference is now made to Fig. 2 for the description of such an exemplary semantic network.

In Fig. 2, reference numeral 6 designates respective semantic units. In addition, reference numeral 3 designates respective linking units of the type "in particular is/in general is", reference numeral 4b designates respective linking units of the type "is similar to", reference numeral 1 designates respective linking units of the type "contains/is part of", reference numeral 5 designates respective linking units of the type "has Janus/function/is Janus/function of", reference numeral 2 designates respective linking units of the type "interacts with", reference numeral 2b

designates respective linking units of the type "is described by/is attribute of", and reference numeral 4c designates respective linking units of the type "follows after/is followed by".

Here it is to be noted that the semantic units at least possess informational contents and that the linking units at least possess relational contents, with the respective relational contents specifying the kind of mutual relation between the semantic units linked by means of a respective linking unit.

In accordance with the exemplary representation in Fig. 2, an association between the semantic unit 6 designated as "object" and the semantic unit 6 designated as "K1", for example, is described by the linking unit 3 of the type "in particular is/in general is" as "object in particular is K1/K1 in general is object". Moreover an association between the semantic unit 6 designated as "A" and the semantic unit 6 designated as "4" is, for example, described by the linking unit 4b of the type "is similar to" as "A is similar to 4/4 is similar to A". The same applies analogously to all of the semantic units shown in Fig. 2 while taking into consideration the respectively used linking units as explained above by referring to Figs. 1a to 1e.

It is thus evident that the linking units 1, 2b, 3, 4c and 5 drawn with an arrow in Fig. 2 are directional linking units, i.e., linking units whose respective type of association has one meaning in one direction and another (opposite) meaning in an opposite direction. In contrast, the linking units 2 and 4b drawn without an arrow in Fig. 2 are bidirectional linking units whose type of association has a same meaning in either direction.

The following is noted with respect to the linking units 5 of the type "has Janus/function/is Janus/function of". These linking units 5 of the type "has Janus/function/is Janus/function of" serve for creating the possibility of introducing particular semantic units into the semantic network, which are capable of carrying out certain operations on other semantic units and/or linking units. Such semantic units are hereinafter referred to as semantic Janus units.

In this context a semantic Janus unit constitutes a particular semantic unit having an algorithm or a collection of algorithms which may change the informational content of semantic units and/or linking units and/or generate new semantic units and/or linking units, or delete existing semantic units and/or linking units. A semantic Janus unit is connected through a respective specific linking unit 5 of the type "has Janus/function/is Janus/function of" with one or several semantic units and/or linking units in whose vicinity the said semantic Janus is to operate.

This means that the functionality of the semantic Janus unit is restricted in such a way as to be merely capable of carrying out the specific operations on those semantic units and/or linking units which are located in a predetermined range of vicinity of a semantic unit and/or linking unit linked thereto. Moreover a semantic Janus unit may be linked with other semantic Janus units and/or with attributes through one or several linking units.

In detail a semantic Janus unit may carry out one or several ones of the following operations: generating new semantic units and/or linking units; bundling already

existing semantic units into a single semantic unit optionally to be newly generated; changing and/or deleting already existing semantic units and/or linking units; comparing existing semantic units and/or linking units; recording and changing values of attributes of semantic units and/or linking units; carrying out an algorithm and/or calculating a function; recording a Janus or part of a Janus, i.e., classifying an algorithm or part of an algorithm.

The essential task of a semantic Janus unit lies in bundling or contexting informational contents. Here, bundling is to be understood as the calculation of informational contents of a semantic unit serving as a center from the informational contents of adjacent semantic units and/or linking units. Contexting is to be understood as the analogously inverted process for bundling, i.e., informational contents of the adjacent semantic units and/or linking units are changed in dependence on the informational contents of the semantic unit serving as a center, with the latter defining the vicinity. In this way it is, for example, possible in a simple manner to constantly receive up-to-date statistics of a set of semantic units (bundling) or to presently pass on changes of basic conditions to a set of semantic units (contexting).

In Fig. 2, accordingly, for example the following semantic Janus units exist: the semantic unit 6 designated as "I", as it is linked through the linking unit 5 of the type "has Janus/function/is Janus/function of" with the semantic unit 6 designated as "A", which thus satisfies the relation "I has Janus/function A/A is Janus/function of I"; the semantic unit 6 designated as "4", as it is linked through the linking unit 5 of the type "has Janus/function/is Janus/function of" with the

semantic unit 6 designated as "3" and thus satisfies the relation "3 has Janus/function 4/4 is Janus/function of 3", and the semantic unit 6 designated as "3", as it is linked through the linking unit 5 of the type "has Janus/function/is Janus/function of" with the semantic unit 6 designated as "M" and thus satisfies the relation "M has Janus/function 3/3 is Janus/function of M".

With regard to further features of the semantic Janus unit, that linking unit 5 of the type "has Janus/function/is Janus/function of" and of the term "vicinity", reference is again made to the present applicant's above mentioned previous application, with the semantic Janus unit in particular representing an essential aspect of the present invention which is used for management in a semantic network in accordance with the detailed description below.

The above mentioned term of vicinity is closely connected with the term distance. A first semantic unit is defined to be adjacent a second semantic unit when a distance between them is smaller than a predetermined or calculated value, i.e. a limit value. Here a measure of the distance of informational and/or connotational contents depends on the semantic units through which the second semantic unit may be reached starting out from the first semantic unit.

It is, for example, possible to calculate the measure of distance with weightings in linking units, with the type of the linking unit equally entering the calculation.

Thus a distance function is used for indicating the distance between two respective semantic units. In order to determine the distance based on the weight of the

linking units, suitable mathematical functions of a variable parameter G may be set as the distance function, with this parameter G being present in every linking unit and expressing the degree of association of respective semantic units. Instead of the parameter G, there is also the possibility of using a classification for defining the vicinity. Moreover an immediate vicinity is defined as one wherein a semantic unit is directly linked with another semantic unit through a linking unit, and a mediate vicinity is defined as one wherein a semantic unit is indirectly linked through several semantic units and/or linking units.

In accordance with the embodiment of the present invention the semantic Janus units existing in a semantic network additionally have, apart from the above mentioned features and properties, a time-variable state making it possible to carry out operations in this semantic network in dependence on an existing situation in the semantic network.

As a result of the time-variable state a temporally dynamic behavior is thus introduced into the semantic network, resulting in a very flexible management within the semantic network.

Inasmuch as a "view" of a semantic Janus unit into the semantic network changes depending on this time-variable state, this time-variable state of a semantic Janus unit expresses a state of excitation or affect in which a semantic Janus unit finds itself.

Operation within the semantic network shall now be described in more detail by referring to the schematic flowchart of Fig. 3.

By means of a rough pattern recognition (Steps S1 and S2) such as, e.g., a statistical examination, a semantic Janus unit records bundled information about informational contents, attributes, functions, and a vicinity of a semantic unit or of a partial network of the semantic network to which the said semantic Janus unit is linked (Step S1).

After this the semantic Janus unit performs an analysis of the bundled information in order to determine what is essential (Step S2). I.e., the semantic Janus unit carries out an analysis to the effect of what informational contents, attributes, functions and/or linking units are "important". It is thus determined what the semantic Janus unit is to concentrate on, with the time-variable state of the semantic Janus unit jointly determining this decision. More precisely, from the vicinity of the semantic unit a vicinity to be monitored is determined which represents a subset of the vicinity. As the semantic Janus unit then concentrates on the vicinity to be monitored, this results in a substantial reduction of information to be processed, and thus considerable economizing of resources.

With the aid of a result of the preceding analysis, a new time-variable state of the semantic Janus unit is then determined (Step S3). It should be noted here that both the existing time-variable state and additional evaluation criteria are introduced into the determination of the new time-variable state.

In general terms, these further evaluation criteria determine what should be carried out when and how. More specifically, these evaluation criteria decide the following:

a) what informational contents of semantic units, what semantic units, or what partial networks are to be treated next;
b) what priorities are set in a semantic unit, in a partial network, or in the entire semantic network;
c) in what manner time-variable states of semantic Janus units are to be deducted from the states of semantic units, of partial networks of the semantic network, or of the entire semantic network;
d) how rapidly time-variable states of semantic Janus units change; and/or
e) in what manner semantic units and/or linking units are treated.

These evaluation criteria may be determined individually for each semantic Janus unit, and accordingly each semantic Janus unit exhibits its own subjective behavior on account of these evaluation criteria. The evaluation criteria thus express a character of the semantic Janus units.

The character and the affect of a semantic Janus unit resemble each other under the aspect that the character has fundamental characteristics corresponding to the affect, with these fundamental characteristics jointly determining the manner in which processing within the semantic network is to be performed. The fundamental difference between a character and an affect of a semantic Janus unit is that the affect, other than the character, is highly dynamic, i.e., following detection of a new situation existing in the semantic network in the course of the rough pattern recognition, the affect may rapidly change depending on this new situation. The character, on the other hand, only exhibits extremely

minimal changes throughout the entire lifetime of a semantic unit, with a lifetime of the semantic unit being understood as a time segment from generation to deletion of the semantic unit. It is here additionally noted that the affect in general is a property having an immediate effect, i.e. one not subject to any time delay.

Following the above mentioned determination of a new time-variable state, the semantic Janus unit focuses or concentrates, respectively, on those informational contents, attributes, functions and/or linking units that were analyzed as being "important" (Step S4). This corresponds to a focused pattern recognition. One example for this is that a semantic Janus unit solely focuses on linking units of the "VA/VH" type and thus of the "exchange without scale change" type.

Following this focusing, the semantic Janus unit analyzes the informational contents, attributes, functions and/or linking units "being focused on" and decides what operations or actions are to be performed (Step S5). In the above mentioned example of the "VA/VH" type linking units "being focused on", a decision may for example be made as to which linking unit or which linking units of this type are to be deleted, or what informational contents of semantic units linked through these linking units are to be changed, etc.

After this the operations decided upon are carried out (Step S6). Such operation may, for example, be the construction of one or several new vicinity linking units and/or the construction of a new kind of vicinity linking unit, corresponding to formation of a structure.

It is thus evident that the vicinity to be shaped, on which the operations are carried out, need not be

identical with the vicinity to be monitored. Rather, depending on the respective situation existing in the semantic network, the time-variable state of the semantic Janus unit and/or the evaluation criteria of the semantic Janus unit, the vicinity to be shaped and the vicinity to be monitored may be different from each other, be identical with each other, or overlap each other. The vicinity to be shaped may herein be determined, e.g., in a way already having been described as an immediate or mediate vicinity, with the time-variable state of the semantic Janus unit entering into this determination.

After this, values of informational contents of the semantic units and/or linking units changed in conformity with the operations are set, new informational contents or new types of informational contents or new semantic units and/or linking units and/or partial networks are introduced (corresponding to an emergence), or semantic units and/or linking units and/or partial networks within the semantic network are changed, deleted etc. (Step S7).

After this the step of rough pattern recognition is again performed, and the procedural flow starts anew.

As is evident from the preceding explanations, a semantic Janus unit has both a vicinity to be monitored and a vicinity to be shaped. The semantic Janus unit monitors the vicinity to be monitored and carries out the operations on the vicinity to be shaped. A respective new state of a semantic Janus unit may be determined from the existing state of the semantic Janus unit and/or from an analysis of an optionally variable monitored vicinity. In addition, the respective new state of the semantic Janus unit may act both on the vicinity to be monitored and on the vicinity to be shaped.

It is one essential aspect of the semantic Janus unit that it may focus in a situation-dependent manner on superobjects, on subobjects, or on adjacent objects of the semantic unit to which it is linked. Superobjects represent semantic units that are situated on a higher scale than the semantic unit to which the semantic Janus unit is linked. Subobjects in turn are semantic units that are situated on a lower scale than the semantic unit to which the semantic Janus unit is linked. Adjacent objects finally are semantic units that are situated on the same scale as the semantic unit to which the semantic Janus unit is linked. Here the introduction of the respective linking units of the superobjects, subobjects and adjacent objects is also possible.

It has been described in the preceding how the vicinity to be monitored and the vicinity to be shaped are derived/deducted from the vicinity of semantic units to which the semantic Janus unit is linked through the linking unit of the type "has Janus/function/is Janus/function of". Besides the linking units of this type, the semantic Janus unit may be linked to further semantic units and/or linking units through linking units of other types. These further semantic units and/or linking units linked with the semantic Janus unit accordingly form superobjects, subobjects or adjacent objects of semantic Janus unit in dependence on the respective type of the linking unit.

This has the result that the vicinity to be monitored and the vicinity to be shaped may also possess vicinity ranges which result from a vicinity relation of the very semantic Janus unit with its superobjects, subobjects and/or adjacent objects. The vicinity ranges taken into consideration in the process may in turn be dependent on the existing, time-variable state of the semantic Janus

unit and change towards a modification of this time-variable state in accordance with the above explanation.

As a result, there is a possibility of a semantic Janus unit equally only focusing on itself. This means that the semantic Janus unit can change or delete its own informational contents or associations or newly generate informational contents or associations or even delete itself. One example for this is a semantic Janus unit searching a new place for itself in the semantic network.

In general terms this means that semantic Janus units are linked with other semantic units through linking units, and that these semantic Janus units may perform operations on themselves, on the semantic units to which they are linked and/or on those to which the latter in turn are directly or indirectly linked and/or on the linking units of these named semantic units. What is essential is that these semantic Janus units possess time-variable states determining what operations are to be carried out on which semantic units and/or linking units.

As a result of the above described measures, it is possible to introduce into a semantic network - apart from a before/after relation of a semantic network which is changed independently of situation - dynamics which detect a very situation existing in the semantic network, decide about further steps to be performed in dependence on this situation, and perform these steps. There is thus the possibility of demand-oriented operation within the semantic network.

In accordance with the above explanation, the time-variable state of the semantic Janus units constitutes an affect.

In order to elucidate the present invention, it is now explained by referring to Fig. 4 how such an affect and its change may be realized.

Fig. 4 shows a system of coordinates in which various affective conditions are entered.

Affects are generally considered as states in which an individual may find itself. From literature, five fundamental states are known: grief, fear, relaxation, surprise and joy. These fundamental states are representative for an accumulation of similar states such as, e.g., anxiety and frustration.

The system of coordinates represented in Fig. 4 derives from such a view. This system of coordinates may be described as a semantic unit within the semantic network. The coordinates of the system are described in two dimensions. The positive x-axis is designated "gain", the negative x-axis is designated "loss", the positive y-axis is designated "important", and the negative y-axis is designated "unimportant".

There is the possibility of deducting additional coordinates, i.e. sub-coordinates, from each axis of the system of coordinates through further attributes such as, e.g., references to objects, time or space.

The semantic units "affects" may be embedded into the system of coordinates of affects. This means that the semantic units "affects" and the semantic unit "system of coordinates of affects" are linked with each other through linking units of the type including a scale change. Analogously, the semantic units "affects" may be linked with other semantic units "affects" through

linking units of the type without scale change. For example a semantic unit "affects" named "in fear" may be linked with the semantic units "affects" named "frustration" or "panic" (neither represented in Fig. 4) through linking units. Moreover, for example, a semantic unit "affects" denominated "acute existential fear" (not shown in Fig. 4) may be a subobject of the semantic unit "in fear" and thus constitute a specialization of the latter, etc. Depending on the situation, this kind of description of affects allows for a rough or detailed description of affects. As a result of such a description of affects, a semantic Janus unit only focuses on bundled, i.e. rough information. Thus bundled information is used in the processes of pattern recognition, decision-making, and also execution of actions in accordance with the above description.

In utilizing the system of coordinates represented in Fig. 4, the above described rough pattern recognition is thus performed as follows.

Initially there is a search for unusual changes in the informational contents, attributes and/or functions of a semantic unit. This is followed by a search for specific changes, such as for example changes in the informational contents of a particular kind of linking units. After this, the overall state of the semantic unit is roughly classified as, e.g., "good" or "bad". Subsequently classification of the entire state of the semantic unit is performed in connection with the result of the above named search for changes as "important", "unimportant", "gain" and "loss".

"Gain", "loss", "important" and "unimportant" are the designations of the axes of the system of coordinates of affects as represented in Fig. 4. Shifts within the

system of coordinates upon a change of the affect, i.e., upon a change of the time-variable state of a semantic Janus unit on the basis of a situation detected in the semantic network may be described with the aid of a set of rules or a model. The layout of such a set of rules or of motion equations of a model may be freely selected by the user in accordance with the purpose of use. For example it is conceivable that an improvement of a situation of a semantic unit may be construed to the effect of the number of vicinity objects having increased. For example this may mean in dependence on a set of rules or a model that a gain results for the overall situation of the semantic unit and thus a change of the affect of a semantic Janus unit in the direction of the positive x-axis results, i.e. a pleasure gain ensures.

The affects thus constitute evolutionary strategies having the purpose of context-dependent focusing on what is essential. The affects may, for example, be described as semantic units embedded in the system of coordinates of affects which is represented in Fig. 4. Due to the affect, the information about the knowledge concerning the situation in which a semantic unit or a partial network finds itself is bundled to only one point within the system of coordinates of affects, i.e., to the currently existing affect. The current affect, i.e. the present time-variable state, of a semantic Janus unit thus represents bundling via the informational contents and via the vicinity of a semantic unit or of a partial network.

The above described manner of using the affect as a strategy for resource management within semantic networks constitutes an entirely novel concept. The affect and optionally the character of a semantic Janus unit may be

utilized for pattern recognition, for decision-making, and for performing actions as well as for perceiving the consequences thereof in both material and immaterial networks. A material network may, for example, be a computer network, an electricity network, a traffic network, a supply network etc. An immaterial network may, for example, be a semantic network within a database, the INTERNET etc. All of these networks may be described as n^{th}-order semantic networks.

The essential advantage of using such resource management in accordance with the above description is the optimum utilization of the available resources such as, e.g., time, by focusing semantic Janus units of semantic units or of a partial network on what is essential. Besides time, the resources may moreover encompass environment resources, information, knowledge and space.

The following is a description of a further development of the embodiment of the present invention.

Time management of a semantic network may be defined as the perception, generation, administration and fashioning of semantic units with the aid of semantic Janus units within the semantic network over the duration of one or several time segments. Moreover a time segment may be defined according to need, e.g., as a semantic unit or as one of the informational contents of a semantic unit. A time segment may comprise one or several time units as informational contents. For example, one time segment may last one hour of calculation time.

Time is accordingly recorded as a semantic unit. In this sense the semantic Janus units may with the aid of selective time segmentation form, sort out, classify,

reposition, delete semantic time units, newly generate them from a combination or from an interaction of other ones (emergence), create connections between them (association, memory functions, learning) or incorporate them into their algorithms such that the latter may form new ones by simulation and expectation (prediction).

Each time segment is formed within a semantic network as a semantic unit. The different duration of the time segments in the vicinity of the semantic time unit is subject to principles of evolutionary selection, i.e., memory functions.

Semantic units within the semantic network may relate to past and/or presence and/or future.

Semantic Janus units may within a virtual semantic network perceived by them virtually reposition, recombine, newly generate, change, delete, replace semantic units and thereby calculate expectations, make predictions, find a new identity etc. Hereby a so-called "simulation within the simulation" becomes possible. This means that the semantic Janus units may possess or newly generate algorithms and/or methods, further develop them, and operate with them in a world of ideas, i.e. in a semantic network of ideas or notions just like in real network. According to need each semantic Janus unit may create within itself, i.e. within the said semantic Janus unit, an image of a partial network and operate on it just as if the image were indeed existing in the network (thought processes).

In order to detect long-term and short-term changes of informational contents of semantic units or of partial networks such as, e.g., of attributes, functions, algorithms, memorize them in the semantic network, put

them in a relation to each other, remember them (memory function), form temporal patterns from them or recognize them, a semantic unit "temporal object" may be defined which contains as an informational content the state of a semantic unit, of a partial network or of the entire network at a time segment. With the aid of corresponding memory functions, the semantic Janus unit can generate temporal objects (time segmentation), replace, delete or arrange them in the network, search or recognize them.

One possible application of the present invention lies, for example, with geometrical structures such as graphic objects having associations among each other. These graphic objects thus constitute semantic units which are linked through linking units. When the above explained procedures are applied, it is, for example, possible to change shapes and/or colors of the graphic objects as a function of a respective existing situation. Here it is advantageous to use vector graphics.

This method may in one application also be used for generating, changing and/or deleting specific semantic units, so-called view units, which have the purpose of graphically or textually representing the existing semantic network, hereinafter referred to as model, to one or several users.

The internal state of the Janus unit generating these view units may both be pre-defined and changed by the user(s). A semantic model unit included by this Janus unit shall presently be referred to as a "central object". Thus the user may, for example, specify that view units are to be generated exclusively for those semantic model units which are located in a given vicinity of the "central object" and may be reached through given types of association. The user may also

interactively carry out a selection and change while the program is running.

In this way a user may concentrate or focus on those sets of problems that are of interest to him.

Further possible applications of the present invention are, for example, the management of supply or disposal networks, robot-networked or agent-networked systems, automation in the field of man-machine communication, pattern recognition, simulation, management of on-line help for computer programs, application in the multi-media field or film industry, controlling a hardware network inside a computer or networking computers, decision-making and pattern recognition in the stock market, on the market or in politics, automatic piloting of vehicles, of production networks within a company, for example by means of simulation, applications in the medical field such as the management of supply networks of hospitals or clinics, management of the communication between physician and patient (e.g., the patient has at his home medical monitoring equipment which is linked through a computer with a corresponding physician's computer), application in on-line monitoring of patients in the intensive care unit or in the operating theater, application in facility management or risk management or organization of learning in the network.

~~With respect to additional features and advantages of the present invention, reference is expressly made to the disclosure of the drawings.~~

Claims

[1.+ 11.] 1. A semantic network comprised of a multiplicity of units, wherein said semantic network contains both semantic units <u>(6)</u> possessing relational contents and also linking units <u>(1a to 4c)</u> describing a relational content which links two respective semantic units <u>(6)</u> such that the mutual relation of the two linked semantic units <u>(6)</u> is determined by the relational content, wherein:

at least some of said semantic units <u>(6)</u> are specific semantic Janus units <u>(5)</u> which are also linked with other semantic units <u>(6)</u> through linking units <u>(1 to 4c)</u>;

the said semantic Janus units <u>(5)</u> are capable of carrying out operations on themselves, on semantic units <u>(6)</u> to which they are linked and/or on those to which these are in turn directly or indirectly linked and/or on the linking units <u>(1 to 4c)</u> of the said mentioned semantic units <u>(6)</u>, <u>and the said semantic Janus units (5) possess time-variable states</u>,

<u>*characterized in that:*</u>

<u>said time-variable states determine what operations are to be carried out on what semantic units (6) and/or linking units (1a to 4c), and</u>

<u>values of informational contents of said semantic units (6) and/or linking units (1 to 4c) changed as a result of the operations of said semantic Janus units (5) are set, new informational contents or new types of informational contents and/or new semantic units and/or linking units (1a to 4c) and/or partial networks are introduced and/or semantic units (6) and/or linking units (1a to 4c) and/or partial</u>

networks within said semantic network are changed or deleted.

[2. A semantic network in accordance with claim 1, *characterized in that* said semantic Janus units have both a vicinity to be monitored, which is monitored by said semantic Janus units, and a vicinity to be shaped on which said semantic Janus units perform operations.]

2. (new) A semantic network in accordance with claim 1, *characterized in that* the time-variable states of the semantic Janus units (5) express a respective situation existing in said semantic network, in dependence on which operating within said semantic network is carried out, wherein focusing on selected parts of said semantic network takes place.

[2.+3.] 3. A semantic network in accordance with claim 1, [2] *characterized in that* said semantic Janus units (5) have both a vicinity to be monitored, which is monitored by said semantic Janus units (5), and a vicinity to be shaped on which said semantic Janus units (5) perform operations, and a respective new time-variable state of said semantic Janus units (5) is determined from the existing time-variable state of said semantic Janus units (5) and/or from an analysis of an optionally variable vicinity to be monitored.

[4. A semantic network in accordance with claim 3, *characterized in that* the respective new time-variable state of said semantic Janus units acts both on the vicinity to be monitored and on the vicinity to be shaped.]

[5. A semantic network in accordance with claim 2 or 3, *characterized in that* said semantic Janus units introduce their own states in the course of analysis.]

[6.] 4. A semantic network in accordance with claim 3 [any one of claims 2 through 5], *characterized in that* said vicinity to be monitored and/or said vicinity to be shaped are formed of a subset of a vicinity of semantic units (6) to which a respective semantic Janus unit (5) is linked, and/or of a subset of a vicinity of the very respective semantic Janus unit (5).

[7.] 5. A semantic network in accordance with any one of claims 1 through 4 [6], *characterized in that* said semantic Janus units (5), dependently on the existing time-variable state, only concentrate on superobjects located on a higher scale, subobjects located on a lower scale, and/or adjacent objects located on a same scale of said semantic units (6) to which they are linked, and/or on said semantic Janus units (5) themselves.

[8.] 6. A semantic network in accordance with claim 5 [7], *characterized in that* said linking units (1a to 4c) are also incorporated with said superobjects, subobjects and/or adjacent objects.

[9.] 7. A semantic network in accordance with any one of claims 1 through 6 [8], *characterized in that* said semantic Janus units (5) furthermore possess evaluation criteria indicating what informational contents of semantic units (6), what semantic units (6), or what partial networks are to be treated next; what priorities are set in a semantic unit (6), in a

partial network, or in said entire semantic network; in what manner time-variable states of semantic Janus units (5) are to be deducted from the states of semantic units (6), of partial networks of said semantic network, or of said entire semantic network; how rapidly time-variable states of semantic Janus units (5) change; and/or in what manner semantic units (6) and/or linking units (1a to 4c) are treated.

[10.] 8. A semantic network in accordance with claim 7 [9], *characterized in that* said evaluation criteria are subject to temporal changes which change only slightly with respect to the time-variable states of said semantic Janus units (5).

[11. A semantic network in accordance with any one of claims 1 to 10, *characterized in that* values of informational contents of said semantic units and/or linking units changed as a result of the operations of said semantic Janus units are set, new informational contents or new types of informational contents and/or new semantic units and/or linking units and/or partial networks are introduced and/or semantic units and/or linking units and/or partial networks within said semantic network are changed or deleted.]

[12.] 9. A semantic network in accordance with any one of claims 1 to 8 [11], *characterized in that* said semantic units (6) are equally capable of changing or deleting their own informational contents or linking units (1a to 4c) and/or generating new informational contents and/or linking units (1a to 4c) or deleting themselves.

[13.] 10. A semantic network in accordance with any one of claims 1 to 9 [12], *characterized in that* said semantic Janus units (5) may also be linked with other semantic Janus units (5) and/or linking units (1a to 4c) through linking units (1a to 4c) and are capable of carrying out operations on these.

[14.] 11. A semantic network in accordance with any one of claims 1 to 10 [13], *characterized in that* said time-variable state of semantic Janus units (5) is defined with the aid of points plotted in a two-dimensional system of coordinates.

[15.] 12. A semantic network in accordance with claim 11 [14], *characterized in that* said time-variable state is shifted with the aid of a set of rules or of motion equations of a model, whereby a new time-variable state is thus defined.

[16.] 13. A semantic network in accordance with any one of claims 1 to 12 [15], *characterized in that* at least parts of said semantic units (6) are graphic objects linked among each other through linking units (1a to 4c).

[17.] 14. A semantic network in accordance with claim 13 [16], *characterized in that* shapes and/or colors of respective graphic objects are changed depending on respective existing, time-variable states of semantic Janus units (5).

[18.] 15. A semantic network in accordance with claim 13 or 14 [16 or 17], *characterized in that* vector graphics are used.

[19. A semantic network in accordance with any one of the preceding claims, *characterized in that*:

time is recorded as a semantic unit;

semantic Janus units may with the aid of selective time segmentation form, sort out, classify, reposition, delete semantic time units, newly generate them from a combination or from an interaction of other ones, create connections between them or incorporate them into their algorithms such that the latter may form new ones through simulation and expectation;

a time segment is formed within a semantic network through a semantic time unit; and

a different duration of the time segments in a vicinity of a semantic time unit is subject to principles of evolutionary selection.]

[20. A semantic network in accordance with claim 19, *characterized in that* semantic time units within said semantic network may relate to past and/or presence and/or future.]

[21.] 16. A semantic network in accordance with any one of claims 13 to 15 [any one of the preceding claims], *characterized in that* semantic Janus units (5) may within a virtual semantic network perceived by them virtually reposition, recombine, newly generate, change, delete, replace semantic units (6) and thereby calculate expectations, make predictions and/or find a new identity.

[22.] 17. A semantic network in accordance with claim 16 [22], *characterized in that* said semantic Janus units

(5) may possess or newly generate algorithms and/or methods, further develop them, and operate with them in a virtual environment just like in real semantic networks, each semantic Janus unit (5) being capable of creating in itself, according to need, an image of a partial network and operating on the latter just as if said image were indeed existing in said semantic network.

[23.] 18. Semantic network in accordance with any one of claims 3 to 17 [2 to 22], *characterized in that* the time-variable state of a semantic Janus unit (5) and/or the selection of the vicinity to be monitored and/or the vicinity to be shaped may interactively be changed by a user or by users.

[24.] 19. A semantic network in accordance with claim 18 [23], *characterized in that* a semantic Janus unit (5) generates, deletes and/or changes semantic view units that present semantic model units of the vicinity to be monitored to the user(s).

Description

n^{th}-order Semantic Network Allowing for Situation-dependent Operation

The present invention relates to an n^{th}-order semantic network, wherein the semantic network is comprised of a multiplicity of units and contains both semantic units possessing relational contents and also linking units describing a relational content which links two respective semantic units such that the mutual relation of the two linked semantic units is determined by the relational content, and in particular a semantic network of this type in which operating within the semantic network is performed in dependence on a respective situation existing in the semantic network.

In the prior art, the term of an "emotional agent" is known in the fields of "artificial intelligence" and "artificial life".

According to the technical literature "*Künstliches Leben, Anspruch und Wirklichkeit*" [≈ Artificial Life, Claim and Reality] by Werner Kinnebrock, 1996, Oldenbourg, ISBN 3486234854, such an emotional agent has the following properties:

a) the agent acts in environments,
b) the agent has a plan of action,
c) the agent is autonomous,
d) the agent has its own memory area or may access memory areas intended for all agents,
e) the agent may assume a defined, specific task within an agent system,

f) the agent possesses learning ability which may be supported or made possible through neuronal networks,

g) the agent has assessment mechanisms,

h) the agent may exhibit a dynamic adaptive behavior, and

i) the agent may possess and exhibit emotions which influence the agent's behavior and are influenced by this behavior.

Such agent systems including agents may be structured hierarchically or operate with distributed control. Here the emotions merely represent moods which are "carried along" when operating in the agent system and thus influence operation within the agent system.

In brief, the above mentioned technical literature describes behavior-based systems which intelligently process information and in addition act in an artificial or real environment such as to solve defined tasks with a maximum degree of success. Evolutionary development and individual learning are two ways in which these systems acquire their abilities.

Moreover it has hitherto been known in the prior art to simulate and describe emotions of humans or animals. Mention is made, for example, of agents or computers capable of exhibiting emotions. The purpose pursued in this thus merely is to simulate, to describe and/or to explain man or the animals.

In current network structures there is a problem which is increasingly significant with a higher complexity of the network structure in that when operating on a network structure, for example the performance limits even of modern computers or computer

networks are reached or even exceeded, for it is necessary to access all the information within the network structure. In just about any material and immaterial network structures in the prior art it is therefore an essential target to utilize a type of management permitting optimum use of available resources, e.g. time. Hitherto used approaches for carrying out such a management are, however, rigid or only little flexible as regards the utilized strategy, and accordingly are only conditionally or not at all applicable with an increasing complexity.

In particular the previous approaches are not suited for carrying out a management or only conditionally suited for demand-oriented operation on network structures such as, for example, semantic networks, while considering respective states that exist within the network structure at specific times.

It is therefore an object of the present invention to furnish a semantic n^{th}-order network whereby demand-oriented operation within the semantic network in dependence on a situation is possible in a flexible manner.

This object is attained in accordance with the invention through the measures indicated in claim 1.

To be more precise, in accordance with the invention a semantic network is furnished which is comprised of a multiplicity of units, with the semantic network having both semantic units possessing relational contents and also linking units which describe a relational content linking two respective semantic units such that the mutual relation of the two semantic units is determined by the relational content. Moreover in this semantic

network at least some of the semantic units are specific semantic Janus units which are also linked with other semantic units through linking units. These semantic units may carry out operations on themselves, on the semantic units to which they are linked and/or on those to which these in turn are directly or indirectly linked and/or on the linking units of these mentioned semantic units. These semantic Janus units in turn possess states that are variable in time and determine what operations are to be carried out on what semantic units and/or linking units.

In this semantic network it is possible, in dependence on a respective situation existing in the semantic network and expressed through the time-variable states of the semantic Janus units, to perform operating within the semantic network, wherein focusing or concentration on selected portions of the semantic network takes place. As a result, these semantic Janus units do not at any time have to deal in detail with all possible informational contents and/or relational contents of semantic units and/or linking units within the semantic network. Resources such as, e.g., time, may accordingly be saved in the semantic network, which would otherwise be required for processing within the semantic network.

Focusing on selected parts of the semantic network secures a substantial reduction of knowledge to be processed and of data to be processed, respectively, so that for example a processing speed may be raised drastically on account of the achieved temporal allotment of resources.

The semantic Janus units preferably have both a vicinity to be monitored, which is monitored by the

semantic Janus units, and a vicinity to be shaped on which the semantic Janus units perform operations.

Moreover a respective new state of a semantic Janus unit may be determined from the existing state of the semantic Janus unit and/or from an analysis of an optionally variable vicinity to be monitored.

Herein there is a possibility of the respective new state of the semantic Janus unit acting both on the vicinity to be monitored and on the vicinity to be shaped.

Further advantageous developments of the present invention are the subject matters of the subclaims.

The present invention shall hereinbelow be explained in more detail by way of an embodiment while referring to the enclosed drawing, wherein:

Figs. 1a to 1e	are representations of linking units usable in a semantic network.
Fig. 2	is a representation of an exemplary semantic network;
Fig. 3	shows a sequence of operation for elucidating operation in a semantic network in accordance with an embodiment of the present invention; and
Fig. 4	shows a system of coordinates of affects which is applicable in the embodiment of the present invention.

With regard to the terms "semantic network", "semantic unit" and "linking unit" employed in the instant application, reference is made to the application by the same applicant having serial no. DE 199 08 204.9 and entitled "n^{th}-order fractal network for handling complex structures", deposited on February 25, 1999, wherein the terms of "semantic network" and "fractal network" are to be considered equivalents. The features disclosed in the above mentioned application with respect to the "fractal network", the "semantic unit" and the "linking unit" are deemed included in the instant application by reference, for these are essential features of the present invention.

Before describing in detail an embodiment of the present invention in the further course, the structure of an exemplary semantic network shall be outlined for the sake of clarity while referring to Figs. 1a to 1e and 2.

Figures 1a to 1e show representations of linking units that are applicable in a semantic network.

Elementary types of linking units conceivably are exchange relations and relations. Exchange relations are defined as those relations describing an abstract, material and/or communicative exchange between semantic units. Relations, on the other hand, are those relational contents of linking units which describe relations of some kind between semantic units. Figs. 1a to 1e show several such elementary linking units describing a respective relational content.

In the case of hierarchically structured knowledge, such as in the semantic network, linking units of the exchange relation type may be further subdivided into two groups.

What is shown in Fig. 1a is a linking unit 1 of the exchange relation type which interconnects semantic units in mutually different hierarchy levels of the n^{th}-order semantic network. What is thus described is the kind of relation of a larger, i.e., superordinate semantic unit with a smaller, i.e. subordinate semantic unit and vice versa. In other words, a scale change is carried out. Linking units having relations which exhibit the two named features, namely, an exchange and a scale change, are hereinafter designated as linking units of the VA/VS type. In the expression "VA/VS", the term "VA" accordingly represents "exchange", while the term "VS" represents "scale change". In simple terms, a like linking unit 1 of the VA/VS type may be regarded to be "A contains B" in the direction of the arrow from A to B shown in Fig. 1a, and "B is part of A" in the opposite direction. This corresponds to the definition of an embedding hierarchy.

Fig. 1b shows linking units 2, 2a and 2b of the exchange relation type which interconnect semantic units in same hierarchy levels of the n^{th}-order semantic network. In other words, no scale change is performed. Linking units having relations which exhibit the two named features, namely, an exchange and no scale change, are hereinafter designated as linking units of the VA/VH type. In the expression "VA/VH" the term "VA" accordingly represents "exchange", and the term "VH" represents "no scale change". In simple terms, a like linking unit 2a of the VA/VH type may be regarded to be "A is input quantity of B" in the direction from A to B, and "B is output quantity of A" in the opposite direction, and such a linking unit 2b of the VA/VH type may be regarded to be "A is described by B" in the direction from A to B, and "B is attribute of A" in the opposite direction.

In the case of hierarchically structured knowledge, as in the semantic network, linking units of the relation type may be further subdivided into two groups.

Fig. 1c shows a linking unit 3 of the relation type which interconnects semantic units in mutually different hierarchy levels of the n^{th}-order semantic network. What is thus described is the kind of relation of a more general semantic unit with a more specific semantic unit and vice versa. In other words, a scale change is performed. Linking units having relations which exhibit the two mentioned features, namely, a relation and a scale change, are hereinafter referred to as linking units of the VR/VS type. In the expression "VR/VS", the term "VR" accordingly represents "relation", and the term "VS" represents "scale change". In simple terms, a like linking unit 3 of the VR/VS type may be regarded to be "A in particular is B" in the direction of the arrow from A to B shown in Fig. 1c, and "B in general is A" in the opposite direction. This corresponds to the definition of a similarity hierarchy.

Fig. 1d shows linking units 4, 4a, 4b and 4c of the relation type which interconnect semantic units in same hierarchy levels of the n^{th}-order semantic network. In other words, no scale change is performed. Linking units having relations which exhibit the two mentioned features, namely, a relation and no scale change, are hereinafter referred to as linking units of the VR/VH type. In the expression "VR/VH", the term "VR" accordingly represents "relation", and the term "VH" represents "no scale change". In simple terms, a like linking unit 4a of the VR/VH type may be regarded to be "A is (locally) adjacent B", a like linking unit 4b of the VR/VH type may be regarded to be "A is similar to B",

and a like linking unit 4c of the VR/VH type in the direction from A to B may be regarded to be "B follows after A" in the direction from A to B and "A is followed by B" in the opposite direction.

Fig. 1e moreover shows another linking unit 5 which may be regarded to be "A has Janus/function B" in the direction from A to B and "B is Janus/function of A" in the opposite direction. With respect to a more detailed description of this linking unit 5, reference is made to the detailed description of the embodiment further below.

It should be noted here that besides the above mentioned types of linking units, any types of linking units may generally be freely selected by a user. It is, however, sensible to define several elementary types of linking units in advance in a basic library.

Finally it should be noted that evidently linking units may both be directional, i.e., directed, and bidirectional, i.e., non-directional.

Reference is now made to Fig. 2 for the description of such an exemplary semantic network.

In Fig. 2, reference numeral 6 designates respective semantic units. In addition, reference numeral 3 designates respective linking units of the type "in particular is/in general is", reference numeral 4b designates respective linking units of the type "is similar to", reference numeral 1 designates respective linking units of the type "contains/is part of", reference numeral 5 designates respective linking units of the type "has Janus/function/is Janus/function of", reference numeral 2 designates respective linking units of the type "interacts with", reference numeral 2b

designates respective linking units of the type "is described by/is attribute of", and reference numeral 4c designates respective linking units of the type "follows after/is followed by".

Here it is to be noted that the semantic units at least possess informational contents and that the linking units at least possess relational contents, with the respective relational contents specifying the kind of mutual relation between the semantic units linked by means of a respective linking unit.

In accordance with the exemplary representation in Fig. 2, an association between the semantic unit 6 designated as "object" and the semantic unit 6 designated as "K1", for example, is described by the linking unit 3 of the type "in particular is/in general is" as "object in particular is K1/K1 in general is object". Moreover an association between the semantic unit 6 designated as "A" and the semantic unit 6 designated as "4" is, for example, described by the linking unit 4b of the type "is similar to" as "A is similar to 4/4 is similar to A". The same applies analogously to all of the semantic units shown in Fig. 2 while taking into consideration the respectively used linking units as explained above by referring to Figs. 1a to 1e.

It is thus evident that the linking units 1, 2b, 3, 4c and 5 drawn with an arrow in Fig. 2 are directional linking units, i.e., linking units whose respective type of association has one meaning in one direction and another (opposite) meaning in an opposite direction. In contrast, the linking units 2 and 4b drawn without an arrow in Fig. 2 are bidirectional linking units whose type of association has a same meaning in either direction.

The following is noted with respect to the linking units 5 of the type "has Janus/function/is Janus/function of". These linking units 5 of the type "has Janus/function/is Janus/function of" serve for creating the possibility of introducing particular semantic units into the semantic network, which are capable of carrying out certain operations on other semantic units and/or linking units. Such semantic units are hereinafter referred to as semantic Janus units.

In this context a semantic Janus unit constitutes a particular semantic unit having an algorithm or a collection of algorithms which may change the informational content of semantic units and/or linking units and/or generate new semantic units and/or linking units, or delete existing semantic units and/or linking units. A semantic Janus unit is connected through a respective specific linking unit 5 of the type "has Janus/function/is Janus/function of" with one or several semantic units and/or linking units in whose vicinity the said semantic Janus is to operate.

This means that the functionality of the semantic Janus unit is restricted in such a way as to be merely capable of carrying out the specific operations on those semantic units and/or linking units which are located in a predetermined range of vicinity of a semantic unit and/or linking unit linked thereto. Moreover a semantic Janus unit may be linked with other semantic Janus units and/or with attributes through one or several linking units.

In detail a semantic Janus unit may carry out one or several ones of the following operations: generating new semantic units and/or linking units; bundling already

existing semantic units into a single semantic unit optionally to be newly generated; changing and/or deleting already existing semantic units and/or linking units; comparing existing semantic units and/or linking units; recording and changing values of attributes of semantic units and/or linking units; carrying out an algorithm and/or calculating a function; recording a Janus or part of a Janus, i.e., classifying an algorithm or part of an algorithm.

The essential task of a semantic Janus unit lies in bundling or contexting informational contents. Here, bundling is to be understood as the calculation of informational contents of a semantic unit serving as a center from the informational contents of adjacent semantic units and/or linking units. Contexting is to be understood as the analogously inverted process for bundling, i.e., informational contents of the adjacent semantic units and/or linking units are changed in dependence on the informational contents of the semantic unit serving as a center, with the latter defining the vicinity. In this way it is, for example, possible in a simple manner to constantly receive up-to-date statistics of a set of semantic units (bundling) or to presently pass on changes of basic conditions to a set of semantic units (contexting).

In Fig. 2, accordingly, for example the following semantic Janus units exist: the semantic unit 6 designated as "I", as it is linked through the linking unit 5 of the type "has Janus/function/is Janus/function of" with the semantic unit 6 designated as "A", which thus satisfies the relation "I has Janus/function A/A is Janus/function of I"; the semantic unit 6 designated as "4", as it is linked through the linking unit 5 of the type "has Janus/function/is Janus/function of" with the

semantic unit 6 designated as "3" and thus satisfies the relation "3 has Janus/function 4/4 is Janus/function of 3", and the semantic unit 6 designated as "3", as it is linked through the linking unit 5 of the type "has Janus/function/is Janus/function of" with the semantic unit 6 designated as "M" and thus satisfies the relation "M has Janus/function 3/3 is Janus/function of M".

With regard to further features of the semantic Janus unit, that linking unit 5 of the type "has Janus/function/is Janus/function of" and of the term "vicinity", reference is again made to the present applicant's above mentioned previous application, with the semantic Janus unit in particular representing an essential aspect of the present invention which is used for management in a semantic network in accordance with the detailed description below.

The above mentioned term of vicinity is closely connected with the term distance. A first semantic unit is defined to be adjacent a second semantic unit when a distance between them is smaller than a predetermined or calculated value, i.e. a limit value. Here a measure of the distance of informational and/or connotational contents depends on the semantic units through which the second semantic unit may be reached starting out from the first semantic unit.

It is, for example, possible to calculate the measure of distance with weightings in linking units, with the type of the linking unit equally entering the calculation.

Thus a distance function is used for indicating the distance between two respective semantic units. In order to determine the distance based on the weight of the

linking units, suitable mathematical functions of a variable parameter G may be set as the distance function, with this parameter G being present in every linking unit and expressing the degree of association of respective semantic units. Instead of the parameter G, there is also the possibility of using a classification for defining the vicinity. Moreover an immediate vicinity is defined as one wherein a semantic unit is directly linked with another semantic unit through a linking unit, and a mediate vicinity is defined as one wherein a semantic unit is indirectly linked through several semantic units and/or linking units.

In accordance with the embodiment of the present invention the semantic Janus units existing in a semantic network additionally have, apart from the above mentioned features and properties, a time-variable state making it possible to carry out operations in this semantic network in dependence on an existing situation in the semantic network.

As a result of the time-variable state a temporally dynamic behavior is thus introduced into the semantic network, resulting in a very flexible management within the semantic network.

Inasmuch as a "view" of a semantic Janus unit into the semantic network changes depending on this time-variable state, this time-variable state of a semantic Janus unit expresses a state of excitation or affect in which a semantic Janus unit finds itself.

Operation within the semantic network shall now be described in more detail by referring to the schematic flowchart of Fig. 3.

By means of a rough pattern recognition (Steps S1 and S2) such as, e.g., a statistical examination, a semantic Janus unit records bundled information about informational contents, attributes, functions, and a vicinity of a semantic unit or of a partial network of the semantic network to which the said semantic Janus unit is linked (Step S1).

After this the semantic Janus unit performs an analysis of the bundled information in order to determine what is essential (Step S2). I.e., the semantic Janus unit carries out an analysis to the effect of what informational contents, attributes, functions and/or linking units are "important". It is thus determined what the semantic Janus unit is to concentrate on, with the time-variable state of the semantic Janus unit jointly determining this decision. More precisely, from the vicinity of the semantic unit a vicinity to be monitored is determined which represents a subset of the vicinity. As the semantic Janus unit then concentrates on the vicinity to be monitored, this results in a substantial reduction of information to be processed, and thus considerable economizing of resources.

With the aid of a result of the preceding analysis, a new time-variable state of the semantic Janus unit is then determined (Step S3). It should be noted here that both the existing time-variable state and additional evaluation criteria are introduced into the determination of the new time-variable state.

In general terms, these further evaluation criteria determine what should be carried out when and how. More specifically, these evaluation criteria decide the following:

a) what informational contents of semantic units, what semantic units, or what partial networks are to be treated next;

b) what priorities are set in a semantic unit, in a partial network, or in the entire semantic network;

c) in what manner time-variable states of semantic Janus units are to be deducted from the states of semantic units, of partial networks of the semantic network, or of the entire semantic network;

d) how rapidly time-variable states of semantic Janus units change; and/or

e) in what manner semantic units and/or linking units are treated.

These evaluation criteria may be determined individually for each semantic Janus unit, and accordingly each semantic Janus unit exhibits its own subjective behavior on account of these evaluation criteria. The evaluation criteria thus express a character of the semantic Janus units.

The character and the affect of a semantic Janus unit resemble each other under the aspect that the character has fundamental characteristics corresponding to the affect, with these fundamental characteristics jointly determining the manner in which processing within the semantic network is to be performed. The fundamental difference between a character and an affect of a semantic Janus unit is that the affect, other than the character, is highly dynamic, i.e., following detection of a new situation existing in the semantic network in the course of the rough pattern recognition, the affect may rapidly change depending on this new situation. The character, on the other hand, only exhibits extremely

minimal changes throughout the entire lifetime of a semantic unit, with a lifetime of the semantic unit being understood as a time segment from generation to deletion of the semantic unit. It is here additionally noted that the affect in general is a property having an immediate effect, i.e. one not subject to any time delay.

Following the above mentioned determination of a new time-variable state, the semantic Janus unit focuses or concentrates, respectively, on those informational contents, attributes, functions and/or linking units that were analyzed as being "important" (Step S4). This corresponds to a focused pattern recognition. One example for this is that a semantic Janus unit solely focuses on linking units of the "VA/VH" type and thus of the "exchange without scale change" type.

Following this focusing, the semantic Janus unit analyzes the informational contents, attributes, functions and/or linking units "being focused on" and decides what operations or actions are to be performed (Step S5). In the above mentioned example of the "VA/VH" type linking units "being focused on", a decision may for example be made as to which linking unit or which linking units of this type are to be deleted, or what informational contents of semantic units linked through these linking units are to be changed, etc.

After this the operations decided upon are carried out (Step S6). Such operation may, for example, be the construction of one or several new vicinity linking units and/or the construction of a new kind of vicinity linking unit, corresponding to formation of a structure.

It is thus evident that the vicinity to be shaped, on which the operations are carried out, need not be

identical with the vicinity to be monitored. Rather, depending on the respective situation existing in the semantic network, the time-variable state of the semantic Janus unit and/or the evaluation criteria of the semantic Janus unit, the vicinity to be shaped and the vicinity to be monitored may be different from each other, be identical with each other, or overlap each other. The vicinity to be shaped may herein be determined, e.g., in a way already having been described as an immediate or mediate vicinity, with the time-variable state of the semantic Janus unit entering into this determination.

After this, values of informational contents of the semantic units and/or linking units changed in conformity with the operations are set, new informational contents or new types of informational contents or new semantic units and/or linking units and/or partial networks are introduced (corresponding to an emergence), or semantic units and/or linking units and/or partial networks within the semantic network are changed, deleted etc. (Step S7).

After this the step of rough pattern recognition is again performed, and the procedural flow starts anew.

As is evident from the preceding explanations, a semantic Janus unit has both a vicinity to be monitored and a vicinity to be shaped. The semantic Janus unit monitors the vicinity to be monitored and carries out the operations on the vicinity to be shaped. A respective new state of a semantic Janus unit may be determined from the existing state of the semantic Janus unit and/or from an analysis of an optionally variable monitored vicinity. In addition, the respective new state of the semantic Janus unit may act both on the vicinity to be monitored and on the vicinity to be shaped.

It is one essential aspect of the semantic Janus unit that it may focus in a situation-dependent manner on superobjects, on subobjects, or on adjacent objects of the semantic unit to which it is linked. Superobjects represent semantic units that are situated on a higher scale than the semantic unit to which the semantic Janus unit is linked. Subobjects in turn are semantic units that are situated on a lower scale than the semantic unit to which the semantic Janus unit is linked. Adjacent objects finally are semantic units that are situated on the same scale as the semantic unit to which the semantic Janus unit is linked. Here the introduction of the respective linking units of the superobjects, subobjects and adjacent objects is also possible.

It has been described in the preceding how the vicinity to be monitored and the vicinity to be shaped are derived/deducted from the vicinity of semantic units to which the semantic Janus unit is linked through the linking unit of the type "has Janus/function/is Janus/function of". Besides the linking units of this type, the semantic Janus unit may be linked to further semantic units and/or linking units through linking units of other types. These further semantic units and/or linking units linked with the semantic Janus unit accordingly form superobjects, subobjects or adjacent objects of semantic Janus unit in dependence on the respective type of the linking unit.

This has the result that the vicinity to be monitored and the vicinity to be shaped may also possess vicinity ranges which result from a vicinity relation of the very semantic Janus unit with its superobjects, subobjects and/or adjacent objects. The vicinity ranges taken into consideration in the process may in turn be dependent on the existing, time-variable state of the semantic Janus

unit and change towards a modification of this time-variable state in accordance with the above explanation.

As a result, there is a possibility of a semantic Janus unit equally only focusing on itself. This means that the semantic Janus unit can change or delete its own informational contents or associations or newly generate informational contents or associations or even delete itself. One example for this is a semantic Janus unit searching a new place for itself in the semantic network.

In general terms this means that semantic Janus units are linked with other semantic units through linking units, and that these semantic Janus units may perform operations on themselves, on the semantic units to which they are linked and/or on those to which the latter in turn are directly or indirectly linked and/or on the linking units of these named semantic units. What is essential is that these semantic Janus units possess time-variable states determining what operations are to be carried out on which semantic units and/or linking units.

As a result of the above described measures, it is possible to introduce into a semantic network - apart from a before/after relation of a semantic network which is changed independently of situation - dynamics which detect a very situation existing in the semantic network, decide about further steps to be performed in dependence on this situation, and perform these steps. There is thus the possibility of demand-oriented operation within the semantic network.

In accordance with the above explanation, the time-variable state of the semantic Janus units constitutes an affect.

In order to elucidate the present invention, it is now explained by referring to Fig. 4 how such an affect and its change may be realized.

Fig. 4 shows a system of coordinates in which various affective conditions are entered.

Affects are generally considered as states in which an individual may find itself. From literature, five fundamental states are known: grief, fear, relaxation, surprise and joy. These fundamental states are representative for an accumulation of similar states such as, e.g., anxiety and frustration.

The system of coordinates represented in Fig. 4 derives from such a view. This system of coordinates may be described as a semantic unit within the semantic network. The coordinates of the system are described in two dimensions. The positive x-axis is designated "gain", the negative x-axis is designated "loss", the positive y-axis is designated "important", and the negative y-axis is designated "unimportant".

There is the possibility of deducting additional coordinates, i.e. sub-coordinates, from each axis of the system of coordinates through further attributes such as, e.g., references to objects, time or space.

The semantic units "affects" may be embedded into the system of coordinates of affects. This means that the semantic units "affects" and the semantic unit "system of coordinates of affects" are linked with each other through linking units of the type including a scale change. Analogously, the semantic units "affects" may be linked with other semantic units "affects" through

linking units of the type without scale change. For example a semantic unit "affects" named "in fear" may be linked with the semantic units "affects" named "frustration" or "panic" (neither represented in Fig. 4) through linking units. Moreover, for example, a semantic unit "affects" denominated "acute existential fear" (not shown in Fig. 4) may be a subobject of the semantic unit "in fear" and thus constitute a specialization of the latter, etc. Depending on the situation, this kind of description of affects allows for a rough or detailed description of affects. As a result of such a description of affects, a semantic Janus unit only focuses on bundled, i.e. rough information. Thus bundled information is used in the processes of pattern recognition, decision-making, and also execution of actions in accordance with the above description.

In utilizing the system of coordinates represented in Fig. 4, the above described rough pattern recognition is thus performed as follows.

Initially there is a search for unusual changes in the informational contents, attributes and/or functions of a semantic unit. This is followed by a search for specific changes, such as for example changes in the informational contents of a particular kind of linking units. After this, the overall state of the semantic unit is roughly classified as, e.g., "good" or "bad". Subsequently classification of the entire state of the semantic unit is performed in connection with the result of the above named search for changes as "important", "unimportant", "gain" and "loss".

"Gain", "loss", "important" and "unimportant" are the designations of the axes of the system of coordinates of affects as represented in Fig. 4. Shifts within the

system of coordinates upon a change of the affect, i.e., upon a change of the time-variable state of a semantic Janus unit on the basis of a situation detected in the semantic network may be described with the aid of a set of rules or a model. The layout of such a set of rules or of motion equations of a model may be freely selected by the user in accordance with the purpose of use. For example it is conceivable that an improvement of a situation of a semantic unit may be construed to the effect of the number of vicinity objects having increased. For example this may mean in dependence on a set of rules or a model that a gain results for the overall situation of the semantic unit and thus a change of the affect of a semantic Janus unit in the direction of the positive x-axis results, i.e. a pleasure gain ensures.

The affects thus constitute evolutionary strategies having the purpose of context-dependent focusing on what is essential. The affects may, for example, be described as semantic units embedded in the system of coordinates of affects which is represented in Fig. 4. Due to the affect, the information about the knowledge concerning the situation in which a semantic unit or a partial network finds itself is bundled to only one point within the system of coordinates of affects, i.e., to the currently existing affect. The current affect, i.e. the present time-variable state, of a semantic Janus unit thus represents bundling via the informational contents and via the vicinity of a semantic unit or of a partial network.

The above described manner of using the affect as a strategy for resource management within semantic networks constitutes an entirely novel concept. The affect and optionally the character of a semantic Janus unit may be

utilized for pattern recognition, for decision-making, and for performing actions as well as for perceiving the consequences thereof in both material and immaterial networks. A material network may, for example, be a computer network, an electricity network, a traffic network, a supply network etc. An immaterial network may, for example, be a semantic network within a database, the INTERNET etc. All of these networks may be described as n^{th}-order semantic networks.

The essential advantage of using such resource management in accordance with the above description is the optimum utilization of the available resources such as, e.g., time, by focusing semantic Janus units of semantic units or of a partial network on what is essential. Besides time, the resources may moreover encompass environment resources, information, knowledge and space.

The following is a description of a further development of the embodiment of the present invention.

Time management of a semantic network may be defined as the perception, generation, administration and fashioning of semantic units with the aid of semantic Janus units within the semantic network over the duration of one or several time segments. Moreover a time segment may be defined according to need, e.g., as a semantic unit or as one of the informational contents of a semantic unit. A time segment may comprise one or several time units as informational contents. For example, one time segment may last one hour of calculation time.

Time is accordingly recorded as a semantic unit. In this sense the semantic Janus units may with the aid of selective time segmentation form, sort out, classify,

reposition, delete semantic time units, newly generate them from a combination or from an interaction of other ones (emergence), create connections between them (association, memory functions, learning) or incorporate them into their algorithms such that the latter may form new ones by simulation and expectation (prediction).

Each time segment is formed within a semantic network as a semantic unit. The different duration of the time segments in the vicinity of the semantic time unit is subject to principles of evolutionary selection, i.e., memory functions.

Semantic units within the semantic network may relate to past and/or presence and/or future.

Semantic Janus units may within a virtual semantic network perceived by them virtually reposition, recombine, newly generate, change, delete, replace semantic units and thereby calculate expectations, make predictions, find a new identity etc. Hereby a so-called "simulation within the simulation" becomes possible. This means that the semantic Janus units may possess or newly generate algorithms and/or methods, further develop them, and operate with them in a world of ideas, i.e. in a semantic network of ideas or notions just like in real network. According to need each semantic Janus unit may create within itself, i.e. within the said semantic Janus unit, an image of a partial network and operate on it just as if the image were indeed existing in the network (thought processes).

In order to detect long-term and short-term changes of informational contents of semantic units or of partial networks such as, e.g., of attributes, functions, algorithms, memorize them in the semantic network, put

them in a relation to each other, remember them (memory function), form temporal patterns from them or recognize them, a semantic unit "temporal object" may be defined which contains as an informational content the state of a semantic unit, of a partial network or of the entire network at a time segment. With the aid of corresponding memory functions, the semantic Janus unit can generate temporal objects (time segmentation), replace, delete or arrange them in the network, search or recognize them.

One possible application of the present invention lies, for example, with geometrical structures such as graphic objects having associations among each other. These graphic objects thus constitute semantic units which are linked through linking units. When the above explained procedures are applied, it is, for example, possible to change shapes and/or colors of the graphic objects as a function of a respective existing situation. Here it is advantageous to use vector graphics.

This method may in one application also be used for generating, changing and/or deleting specific semantic units, so-called view units, which have the purpose of graphically or textually representing the existing semantic network, hereinafter referred to as model, to one or several users.

The internal state of the Janus unit generating these view units may both be pre-defined and changed by the user(s). A semantic model unit included by this Janus unit shall presently be referred to as a "central object". Thus the user may, for example, specify that view units are to be generated exclusively for those semantic model units which are located in a given vicinity of the "central object" and may be reached through given types of association. The user may also

interactively carry out a selection and change while the program is running.

In this way a user may concentrate or focus on those sets of problems that are of interest to him.

Further possible applications of the present invention are, for example, the management of supply or disposal networks, robot-networked or agent-networked systems, automation in the field of man-machine communication, pattern recognition, simulation, management of on-line help for computer programs, application in the multi-media field or film industry, controlling a hardware network inside a computer or networking computers, decision-making and pattern recognition in the stock market, on the market or in politics, automatic piloting of vehicles, of production networks within a company, for example by means of simulation, applications in the medical field such as the management of supply networks of hospitals or clinics, management of the communication between physician and patient (e.g., the patient has at his home medical monitoring equipment which is linked through a computer with a corresponding physician's computer), application in on-line monitoring of patients in the intensive care unit or in the operating theater, application in facility management or risk management or organization of learning in the network.

With respect to additional features and advantages of the present invention, reference is expressly made to the disclosure of the drawings.

Claims

1. A semantic network comprised of a multiplicity of units, wherein said semantic network contains both semantic units possessing relational contents and also linking units describing a relational content which links two respective semantic units such that the mutual relation of the two linked semantic units is determined by the relational content, wherein:

   at least some of said semantic units are specific semantic Janus units which are also linked with other semantic units through linking units;

   the said semantic Janus units are capable of carrying out operations on themselves, on semantic units to which they are linked and/or on those to which these are in turn directly or indirectly linked and/or on the linking units of the said mentioned semantic units; and

   the said semantic Janus units possess time-variable states that determine what operations are to be carried out on what semantic units and/or linking units.

2. A semantic network in accordance with claim 1, *characterized in that* said semantic Janus units have both a vicinity to be monitored, which is monitored by said semantic Janus units, and a vicinity to be shaped on which said semantic Janus units perform operations.

3. A semantic network in accordance with claim 2, *characterized in that* a respective new time-variable state of said semantic Janus units is determined from the existing time-variable state of said semantic

Janus units and/or from an analysis of an optionally variable vicinity to be monitored.

4. A semantic network in accordance with claim 3, *characterized in that* the respective new time-variable state of said semantic Janus units acts both on the vicinity to be monitored and on the vicinity to be shaped.

5. A semantic network in accordance with claim 2 or 3, *characterized in that* said semantic Janus units introduce their own states in the course of analysis.

6. A semantic network in accordance with any one of claims 2 to 5, *characterized in that* said vicinity to be monitored and/or said vicinity to be shaped are formed of a subset of a vicinity of semantic units to which a respective semantic Janus unit is linked, and/or of a subset of a vicinity of the very respective semantic Janus unit.

7. A semantic network in accordance with any one of claims 1 to 6, *characterized in that* said semantic Janus units, dependently on the existing time-variable state, only concentrate on superobjects located on a higher scale, subobjects located on a lower scale, and/or adjacent objects located on a same scale of said semantic units to which they are linked, and/or on said semantic Janus units themselves.

8. A semantic network in accordance with claim 7, *characterized in that* said linking units are also incorporated with said superobjects, subobjects and/or adjacent objects.

9. A semantic network in accordance with any one of claims 1 to 8, *characterized in that* said semantic Janus units furthermore possess evaluation criteria indicating what informational contents of semantic units, what semantic units, or what partial networks are to be treated next; what priorities are set in a semantic unit, in a partial network, or in said entire semantic network; in what manner time-variable states of semantic Janus units are to be deducted from the states of semantic units, of partial networks of said semantic network, or of said entire semantic network; how rapidly time-variable states of semantic Janus units change; and/or in what manner semantic units and/or linking units are treated.

10. A semantic network in accordance with claim 9, *characterized in that* said evaluation criteria are subject to temporal changes which change only slightly with respect to the time-variable states of said semantic Janus units.

11. A semantic network in accordance with any one of claims 1 to 10, *characterized in that* values of informational contents of said semantic units and/or linking units changed as a result of the operations of said semantic Janus units are set, new informational contents or new types of informational contents and/or new semantic units and/or linking units and/or partial networks are introduced and/or semantic units and/or linking units and/or partial networks within said semantic network are changed or deleted.

12. A semantic network in accordance with any one of claims 1 to 11, *characterized in that* said semantic units are equally capable of changing or deleting

their own informational contents or associations and/or generating new informational contents and/or new associations or deleting themselves.

13. A semantic network in accordance with any one of claims 1 to 12, *characterized in that* said semantic Janus units may also be linked with other semantic Janus units and/or linking units through linking units and are capable of carrying out operations on these.

14. A semantic network in accordance with any one of claims 1 to 13, *characterized in that* said time-variable state of semantic Janus units is defined with the aid of points plotted in a two-dimensional system of coordinates.

15. A semantic network in accordance with claim 14, *characterized in that* said time-variable state is shifted with the aid of a set of rules or of motion equations of a model, whereby a new time-variable state is thus defined.

16. A semantic network in accordance with any one of claims 1 to 15, *characterized in that* at least parts of said semantic units are graphic objects linked among each other through linking units.

17. A semantic network in accordance with claim 16, *characterized in that* shapes and/or colors of respective graphic objects are changed depending on respective existing, time-variable states of semantic Janus units.

18. Semantic network in accordance with claim 16 or 17, *characterized in that* vector graphics are used.

19. A semantic network in accordance with any one of the preceding claims, *characterized in that*:

time is recorded as a semantic unit;

semantic Janus units may with the aid of selective time segmentation form, sort out, classify, reposition, delete semantic time units, newly generate them from a combination or from an interaction of other ones, create connections between them or incorporate them into their algorithms such that the latter may form new ones through simulation and expectation;

a time segment is formed within a semantic network through a semantic time unit; and

a different duration of the time segments in a vicinity of a semantic time unit is subject to principles of evolutionary selection.

20. A semantic network in accordance with claim 19, *characterized in that* semantic time units within said semantic network may relate to past and/or presence and/or future.

21. A semantic network in accordance with any one of the preceding claims, *characterized in that* semantic Janus units may within a virtual semantic network perceived by them virtually reposition, recombine, newly generate, change, delete, replace semantic units and thereby calculate expectations, make predictions and/or find a new identity.

22. A semantic network in accordance with claim 21, *characterized in that* said semantic Janus units may

possess or newly generate algorithms and/or methods, further develop them, and operate with them in a virtual environment just like in real semantic networks, each semantic Janus unit being capable of creating in itself, according to need, an image of a partial network and operating on the latter just as if said image were indeed existing in said semantic network.

23. A semantic network in accordance with any one of claims 2 to 22, *characterized in that* the time-variable state of a semantic Janus unit and/or the selection of the vicinity to be monitored and/or the vicinity to be shaped may interactively be changed by a user or by users.

24. A semantic network in accordance with claim 23, *characterized in that* a semantic Janus unit generates, deletes and/or changes semantic view units that present semantic model units of the vicinity to be monitored to the user(s).

Abstract

nth-order Semantic Network Allowing for Situation-dependent Operation

A semantic network is being disclosed which is comprised of a multiplicity of units, wherein the semantic network contains both semantic units possessing relational contents and also linking units describing a relational content which links two respective semantic units such that the mutual relation of the two linked semantic units is determined by the relational content. In this network at least some of the semantic units are specific semantic Janus units which are also linked with other semantic units through linking units. These semantic Janus units are moreover capable of carrying out operations on themselves, on the semantic units to which they are linked and/or on those to which these in turn are directly or indirectly linked and/or on the linking units of the mentioned semantic units. These semantic Janus units possess time-variable states that determine what operations are to be carried out on what semantic units and/or linking units.

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Description

n^{th}-order Semantic Network Allowing for Situation-dependent Operation

The present invention relates to an n^{th}-order semantic network in accordance with the preamble of claim 1 and in particular a semantic network of this type in which operating within the semantic network is performed in dependence on a respective situation existing in the semantic network.

In the prior art, the term of an "emotional agent" is known in the fields of "artificial intelligence" and "artificial life".

According to the technical literature "*Künstliches Leben, Anspruch und Wirklichkeit*" [Artificial Life, Claim and Reality] by Werner Kinnebrock, 1996, Oldenbourg, ISBN 3486234854, such an emotional agent has the following properties:

a) the agent acts in environments,
b) the agent has a plan of action,
c) the agent is autonomous,
d) the agent has its own memory area or may access memory areas intended for all agents,
e) the agent may assume a defined, specific task within an agent system,
f) the agent possesses learning ability which may be supported or made possible through neuronal networks,
g) the agent has assessment mechanisms,
h) the agent may exhibit a dynamic adaptive behavior, and
i) the agent may possess and exhibit emotions which influence the agent's behavior and are influenced by this behavior.

Such agent systems including agents may be structured hierarchically or operate with distributed control. Here the emotions merely represent moods which are "carried along" when operating in the agent system and thus influence operation within the agent system.

In brief, the above mentioned technical literature describes behavior-based systems which intelligently process information and in addition act in an artificial or real environment such as to solve defined tasks with a maximum degree of success. Evolutionary development and individual learning are two ways in which these systems acquire their abilities.

Moreover it has hitherto been known in the prior art to simulate and describe emotions of humans or animals. Mention is made, for example, of agents or computers capable of exhibiting emotions. The purpose pursued in this thus merely is to simulate, to describe and/or to explain man or the animals.

In current network structures there is a problem which is increasingly significant with a higher complexity of the network structure in that when operating on a network structure, for example the performance limits even of modern computers or computer networks are reached or even exceeded, for it is necessary to access all the information within the network structure. In just about any material and immaterial network structures in the prior art it is therefore an essential target to utilize a type of management permitting optimum use of available resources, e.g. time. Hitherto used approaches for carrying out such a management are, however, rigid or only little flexible as regards the utilized strategy, and accordingly are only conditionally or not at all applicable with an increasing complexity.

In particular the previous approaches are not suited for carrying out a management or only conditionally suited for demand-oriented operation on network structures such as, for example, semantic networks, while considering respective states that exist within the network structure at specific times.

A semantic network in accordance with the preamble of claim 1 is known from LIM E-P et al.: "SEMANTIC NETWORKS AND ASSOCIATIVE DATABASES: TWO APPROACHES TO KNOWLEDGE REPRESENTATION AND REASONING", IEEE Expert, U.S., NY, Vol. 7, No. 4, August 1992, pp. 31 to 40.

It is therefore an object of the present invention to furnish a semantic n^{th}-order network whereby demand-oriented operation within the semantic network in dependence on a situation is possible in a flexible manner.

This object is attained in accordance with the invention through the measures indicated in claim 1.

In the semantic network in accordance with claim 1 it is possible, in dependence on a respective situation existing in the semantic network and expressed through the time-variable states of the semantic Janus units, to perform operating within the semantic network, wherein focusing or concentration on selected portions of the semantic network takes place. As a result, these semantic Janus units do not at any time have to deal in detail with all possible informational contents and/or relational contents of semantic units and/or linking units within the semantic network. Resources such as e.g. time, may accordingly be saved in the semantic network, which would otherwise be required for processing within the semantic network.

Focusing on selected parts of the semantic network secures a substantial reduction of knowledge to be processed and of data to be processed, respectively, so that for example a processing speed may be raised drastically on account of the achieved temporal allotment of resources.

Further advantageous developments of the present invention are the subject matters of the subclaims.

The present invention shall hereinbelow be explained in more detail by way of an embodiment while referring to the enclosed drawing, wherein:

Figs. 1a to 1e are representations of linking units usable in a semantic network.

Fig. 2 is a representation of an exemplary semantic network;

Fig. 3 shows a sequence of operation for elucidating operation in a semantic network in accordance with an embodiment of the present invention; and

Fig. 4 shows a system of coordinates of affects which is applicable in the embodiment of the present invention.

With regard to the terms "semantic network", "semantic unit" and "linking unit" employed in the instant application, reference is made to DE 199 08 204.9 entitled "n^{th}-order fractal network for handling complex structures", wherein the terms of "semantic network" and "fractal network" are to be considered equivalents.

Before describing in detail an embodiment of the present invention in the further course, the structure of an exemplary semantic network shall be outlined for the sake of clarity while referring to Figs. 1a to 1e and 2.

Figures 1a to 1e show representations of linking units that are applicable in a semantic network.

Elementary types of linking units conceivably are exchange relations and relations. Exchange relations are defined as those relations describing an abstract, material and/or communicative exchange between semantic units. Relations, on the other hand, are those relational contents of linking units which describe relations of some kind between semantic units. Figs. 1a to 1e show several such elementary linking units describing a respective relational content.

In the case of hierarchically structured knowledge, such as in the semantic network, linking units of the exchange relation type may be further subdivided into two groups.

What is shown in Fig. 1a is a linking unit 1 of the exchange relation type which interconnects semantic units in mutually different hierarchy levels of the n^{th}-order semantic network. What is thus described is the kind of relation of a larger, i.e., superordinate semantic unit with a smaller, i.e. subordinate semantic unit and vice versa. In other words, a scale change is carried out. Linking units having relations which exhibit the two named features, namely, an exchange and a scale change, are hereinafter designated as linking units of the VA/VS type. In the expression "VA/VS", the term "VA" accordingly represents "exchange", while the term "VS" represents "scale change". In simple terms, a like linking unit 1 of the VA/VS type may be regarded to be "A contains B" in the direction of the arrow from A to B shown in Fig. 1a, and

"B is part of A" in the opposite direction. This corresponds to the definition of an embedding hierarchy.

Fig. 1b shows linking units 2, 2a and 2b of the exchange relation type which interconnect semantic units in same hierarchy levels of the n^{th}-order semantic network. In other words, no scale change is performed. Linking units having relations which exhibit the two named features, namely, an exchange and no scale change, are hereinafter designated as linking units of the VA/VH type. In the expression "VA/VH" the term "VA" accordingly represents "exchange", and the term "VH" represents "no scale change". In simple terms, a like linking unit 2a of the VA/VH type may be regarded to be "A is input quantity of B" in the direction from A to B, and "B is output quantity of A" in the opposite direction, and such a linking unit 2b of the VA/VH type may be regarded to be "A is described by B" in the direction from A to B, and "B is attribute of A" in the opposite direction.

In the case of hierarchically structured knowledge, as in the semantic network, linking units of the relation type may be further subdivided into two groups.

Fig. 1c shows a linking unit 3 of the relation type which interconnects semantic units in mutually different hierarchy levels of the n^{th}-order semantic network. What is thus described is the kind of relation of a more general semantic unit with a more specific semantic unit and vice versa. In other words, a scale change is performed. Linking units having relations which exhibit the two mentioned features, namely, a relation and a scale change, are hereinafter referred to as linking units of the VR/VS type. In the expression "VR/VS", the term "VR" accordingly represents "relation", and the term "VS" represents "scale change". In simple terms, a like linking unit 3 of the VR/VS type may be regarded to be "A in particular is B" in the direction of the arrow from A to B

shown in Fig. 1c, and "B in general is A" in the opposite direction. This corresponds to the definition of a similarity hierarchy.

Fig. 1d shows linking units 4, 4a, 4b and 4c of the relation type which interconnect semantic units in same hierarchy levels of the n^{th}-order semantic network. In other words, no scale change is performed. Linking units having relations which exhibit the two mentioned features, namely, a relation and no scale change, are hereinafter referred to as linking units of the VR/VH type. In the expression "VR/VH", the term "VR" accordingly represents "relation", and the term "VH" represents "no scale change". In simple terms, a like linking unit 4a of the VR/VH type may be regarded to be "A is (locally) adjacent B", a like linking unit 4b of the VR/VH type may be regarded to be "A is similar to B", and a like linking unit 4c of the VR/VH type in the direction from A to B may be regarded to be "B follows after A" in the direction from A to B and "A is followed by B" in the opposite direction.

Fig. 1e moreover shows another linking unit 5 which may be regarded to be "A has Janus/function B" in the direction from A to B and "B is Janus/function of A" in the opposite direction. With respect to a more detailed description of this linking unit 5, reference is made to the detailed description of the embodiment further below.

It should be noted here that besides the above mentioned types of linking units, any types of linking units may generally be freely selected by a user. It is, however, sensible to define several elementary types of linking units in advance in a basic library.

Finally it should be noted that evidently linking units may both be directional, i.e., directed, and bidirectional, i.e., non-directional.

Reference is now made to Fig. 2 for the description of such an exemplary semantic network.

In Fig. 2, reference numeral 6 designates respective semantic units. In addition, reference numeral 3 designates respective linking units of the type "in particular is/in general is", reference numeral 4b designates respective linking units of the type "is similar to", reference numeral 1 designates respective linking units of the type "contains/is part of", reference numeral 5 designates respective linking units of the type "has Janus/function/is Janus/function of", reference numeral 2 designates respective linking units of the type "interacts with", reference numeral 2b designates respective linking units of the type "is described by/is attribute of", and reference numeral 4c designates respective linking units of the type "follows after/is followed by".

Here it is to be noted that the semantic units at least possess informational contents and that the linking units at least possess relational contents, with the respective relational contents specifying the kind of mutual relation between the semantic units linked by means of a respective linking unit.

In accordance with the exemplary representation in Fig. 2, an association between the semantic unit 6 designated as "object" and the semantic unit 6 designated as "K1", for example, is described by the linking unit 3 of the type "in particular is/in general is" as "object in particular is K1/K1 in general is object". Moreover an association between the semantic unit 6 designated as "A" and the semantic unit 6 designated as "4" is, for example, described by the linking unit 4b of the type "is similar to" as "A is similar to 4/4 is similar to A". The same applies analogously to all of the semantic units shown in

Fig. 2 while taking into consideration the respectively used linking units as explained above by referring to Figs. 1a to 1e.

It is thus evident that the linking units 1, 2b, 3, 4c and 5 drawn with an arrow in Fig. 2 are directional linking units, i.e., linking units whose respective type of association has one meaning in one direction and another (opposite) meaning in an opposite direction. In contrast, the linking units 2 and 4b drawn without an arrow in Fig. 2 are bidirectional linking units whose type of association has a same meaning in either direction.

The following is noted with respect to the linking units 5 of the type "has Janus/function/is Janus/function of". These linking units 5 of the type "has Janus/function/is Janus/function of" serve for creating the possibility of introducing particular semantic units into the semantic network, which are capable of carrying out certain operations on other semantic units and/or linking units. Such semantic units are hereinafter referred to as semantic Janus units.

In this context a semantic Janus unit constitutes a particular semantic unit having an algorithm or a collection of algorithms which may change the informational content of semantic units and/or linking units and/or generate new semantic units and/or linking units, or delete existing semantic units and/or linking units. A semantic Janus unit is connected through a respective specific linking unit 5 of the type "has Janus/function/is Janus/function of" with one or several semantic units and/or linking units in whose vicinity the said semantic Janus is to operate.

This means that the functionality of the semantic Janus unit is restricted in such a way as to be merely capable of carrying out the specific operations on those

semantic units and/or linking units which are located in a predetermined range of vicinity of a semantic unit and/or linking unit linked thereto. Moreover a semantic Janus unit may be linked with other semantic Janus units and/or with attributes through one or several linking units.

In detail a semantic Janus unit may carry out one or several ones of the following operations: generating new semantic units and/or linking units; bundling already existing semantic units into a single semantic unit optionally to be newly generated; changing and/or deleting already existing semantic units and/or linking units; comparing existing semantic units and/or linking units; recording and changing values of attributes of semantic units and/or linking units; carrying out an algorithm and/or calculating a function; recording a Janus or part of a Janus, i.e., classifying an algorithm or part of an algorithm.

The essential task of a semantic Janus unit lies in bundling or contexting informational contents. Here, bundling is to be understood as the calculation of informational contents of a semantic unit serving as a center from the informational contents of adjacent semantic units and/or linking units. Contexting is to be understood as the analogously inverted process for bundling, i.e., informational contents of the adjacent semantic units and/or linking units are changed in dependence on the informational contents of the semantic unit serving as a center, with the latter defining the vicinity. In this way it is, for example, possible in a simple manner to constantly receive up-to-date statistics of a set of semantic units (bundling) or to presently pass on changes of basic conditions to a set of semantic units (contexting).

In Fig. 2, accordingly, for example the following semantic Janus units exist: the semantic unit 6 designated

as "I", as it is linked through the linking unit 5 of the type "has Janus/function/is Janus/function of" with the semantic unit 6 designated as "A", which thus satisfies the relation "I has Janus/function A/A is Janus/function of I"; the semantic unit 6 designated as "4", as it is linked through the linking unit 5 of the type "has Janus/function/is Janus/function of" with the semantic unit 6 designated as "3" and thus satisfies the relation "3 has Janus/function 4/4 is Janus/function of 3", and the semantic unit 6 designated as "3", as it is linked through the linking unit 5 of the type "has Janus/function/is Janus/function of" with the semantic unit 6 designated as "M" and thus satisfies the relation "M has Janus/function 3/3 is Janus/function of M".

With regard to further features of the semantic Janus unit, that linking unit 5 of the type "has Janus/function/is Janus/function of" and of the term "vicinity", reference is again made to the present applicant's above mentioned previous application, with the semantic Janus unit in particular representing an essential aspect of the present invention which is used for management in a semantic network in accordance with the detailed description below.

The above mentioned term of vicinity is closely connected with the term distance. A first semantic unit is defined to be adjacent a second semantic unit when a distance between them is smaller than a predetermined or calculated value, i.e. a limit value. Here a measure of the distance of informational and/or connotational contents depends on the semantic units through which the second semantic unit may be reached starting out from the first semantic unit.

It is, for example, possible to calculate the measure of distance with weightings in linking units, with the type of the linking unit equally entering the calculation.

Thus a distance function is used for indicating the distance between two respective semantic units. In order to determine the distance based on the weight of the linking units, suitable mathematical functions of a variable parameter G may be set as the distance function, with this parameter G being present in every linking unit and expressing the degree of association of respective semantic units. Instead of the parameter G, there is also the possibility of using a classification for defining the vicinity. Moreover an immediate vicinity is defined as one wherein a semantic unit is directly linked with another semantic unit through a linking unit, and a mediate vicinity is defined as one wherein a semantic unit is indirectly linked through several semantic units and/or linking units.

In accordance with the embodiment of the present invention the semantic Janus units existing in a semantic network additionally have, apart from the above mentioned features and properties, a time-variable state making it possible to carry out operations in this semantic network in dependence on an existing situation in the semantic network.

As a result of the time-variable state a temporally dynamic behavior is thus introduced into the semantic network, resulting in a very flexible management within the semantic network.

Inasmuch as a "view" of a semantic Janus unit into the semantic network changes depending on this time-variable state, this time-variable state of a semantic Janus unit expresses a state of excitation or affect in which a semantic Janus unit finds itself.

Operation within the semantic network shall now be described in more detail by referring to the schematic flowchart of Fig. 3.

By means of a rough pattern recognition (Steps S1 and S2) such as, e.g., a statistical examination, a semantic Janus unit records bundled information about informational contents, attributes, functions, and a vicinity of a semantic unit or of a partial network of the semantic network to which the said semantic Janus unit is linked (Step S1).

After this the semantic Janus unit performs an analysis of the bundled information in order to determine what is essential (Step S2). I.e., the semantic Janus unit carries out an analysis to the effect of what informational contents, attributes, functions and/or linking units are "important". It is thus determined what the semantic Janus unit is to concentrate on, with the time-variable state of the semantic Janus unit jointly determining this decision. More precisely, from the vicinity of the semantic unit a vicinity to be monitored is determined which represents a subset of the vicinity. As the semantic Janus unit then concentrates on the vicinity to be monitored, this results in a substantial reduction of information to be processed, and thus considerable economizing of resources.

With the aid of a result of the preceding analysis, a new time-variable state of the semantic Janus unit is then determined (Step S3). It should be noted here that both the existing time-variable state and additional evaluation criteria are introduced into the determination of the new time-variable state.

In general terms, these further evaluation criteria determine what should be carried out when and how. More

specifically, these evaluation criteria decide the following:

a) what informational contents of semantic units, what semantic units, or what partial networks are to be treated next;
b) what priorities are set in a semantic unit, in a partial network, or in the entire semantic network;
c) in what manner time-variable states of semantic Janus units are to be deducted from the states of semantic units, of partial networks of the semantic network, or of the entire semantic network;
d) how rapidly time-variable states of semantic Janus units change; and/or
e) in what manner semantic units and/or linking units are treated.

These evaluation criteria may be determined individually for each semantic Janus unit, and accordingly each semantic Janus unit exhibits its own subjective behavior on account of these evaluation criteria. The evaluation criteria thus express a character of the semantic Janus units.

The character and the affect of a semantic Janus unit resemble each other under the aspect that the character has fundamental characteristics corresponding to the affect, with these fundamental characteristics jointly determining the manner in which processing within the semantic network is to be performed. The fundamental difference between a character and an affect of a semantic Janus unit is that the affect, other than the character, is highly dynamic, i.e., following detection of a new situation existing in the semantic network in the course of the rough pattern recognition, the affect may rapidly change depending on this new situation. The character, on

the other hand, only exhibits extremely minimal changes throughout the entire lifetime of a semantic unit, with a lifetime of the semantic unit being understood as a time segment from generation to deletion of the semantic unit. It is here additionally noted that the affect in general is a property having an immediate effect, i.e. one not subject to any time delay.

Following the above mentioned determination of a new time-variable state, the semantic Janus unit focuses or concentrates, respectively, on those informational contents, attributes, functions and/or linking units that were analyzed as being "important" (Step S4). This corresponds to a focused pattern recognition. One example for this is that a semantic Janus unit solely focuses on linking units of the "VA/VH" type and thus of the "exchange without scale change" type.

Following this focusing, the semantic Janus unit analyzes the informational contents, attributes, functions and/or linking units "being focused on" and decides what operations or actions are to be performed (Step S5). In the above mentioned example of the "VA/VH" type linking units "being focused on", a decision may for example be made as to which linking unit or which linking units of this type are to be deleted, or what informational contents of semantic units linked through these linking units are to be changed, etc.

After this the operations decided upon are carried out (Step S6). Such operation may, for example, be the construction of one or several new vicinity linking units and/or the construction of a new kind of vicinity linking unit, corresponding to formation of a structure.

It is thus evident that the vicinity to be shaped, on which the operations are carried out, need not be identical with the vicinity to be monitored. Rather,

depending on the respective situation existing in the semantic network, the time-variable state of the semantic Janus unit and/or the evaluation criteria of the semantic Janus unit, the vicinity to be shaped and the vicinity to be monitored may be different from each other, be identical with each other, or overlap each other. The vicinity to be shaped may herein be determined, e.g., in a way already having been described as an immediate or mediate vicinity, with the time-variable state of the semantic Janus unit entering into this determination.

After this, values of informational contents of the semantic units and/or linking units changed in conformity with the operations are set, new informational contents or new types of informational contents or new semantic units and/or linking units and/or partial networks are introduced (corresponding to an emergence), or semantic units and/or linking units and/or partial networks within the semantic network are changed, deleted etc. (Step S7).

After this the step of rough pattern recognition is again performed, and the procedural flow starts anew.

As is evident from the preceding explanations, a semantic Janus unit has both a vicinity to be monitored and a vicinity to be shaped. The semantic Janus unit monitors the vicinity to be monitored and carries out the operations on the vicinity to be shaped. A respective new state of a semantic Janus unit may be determined from the existing state of the semantic Janus unit and/or from an analysis of an optionally variable monitored vicinity. In addition, the respective new state of the semantic Janus unit may act both on the vicinity to be monitored and on the vicinity to be shaped.

It is one essential aspect of the semantic Janus unit that it may focus in a situation-dependent manner on superobjects, on subobjects, or on adjacent objects of the

semantic unit to which it is linked. Superobjects represent semantic units that are situated on a higher scale than the semantic unit to which the semantic Janus unit is linked. Subobjects in turn are semantic units that are situated on a lower scale than the semantic unit to which the semantic Janus unit is linked. Adjacent objects finally are semantic units that are situated on the same scale as the semantic unit to which the semantic Janus unit is linked. Here the introduction of the respective linking units of the superobjects, subobjects and adjacent objects is also possible.

It has been described in the preceding how the vicinity to be monitored and the vicinity to be shaped are derived/deducted from the vicinity of semantic units to which the semantic Janus unit is linked through the linking unit of the type "has Janus/function/is Janus/function of". Besides the linking units of this type, the semantic Janus unit may be linked to further semantic units and/or linking units through linking units of other types. These further semantic units and/or linking units linked with the semantic Janus unit accordingly form superobjects, subobjects or adjacent objects of semantic Janus unit in dependence on the respective type of the linking unit.

This has the result that the vicinity to be monitored and the vicinity to be shaped may also possess vicinity ranges which result from a vicinity relation of the very semantic Janus unit with its superobjects, subobjects and/or adjacent objects. The vicinity ranges taken into consideration in the process may in turn be dependent on the existing, time-variable state of the semantic Janus unit and change towards a modification of this time-variable state in accordance with the above explanation.

As a result, there is a possibility of a semantic Janus unit equally only focusing on itself. This means

that the semantic Janus unit can change or delete its own informational contents or associations or newly generate informational contents or associations or even delete itself. One example for this is a semantic Janus unit searching a new place for itself in the semantic network.

In general terms this means that semantic Janus units are linked with other semantic units through linking units, and that these semantic Janus units may perform operations on themselves, on the semantic units to which they are linked and/or on those to which the latter in turn are directly or indirectly linked and/or on the linking units of these named semantic units. What is essential is that these semantic Janus units possess time-variable states determining what operations are to be carried out on which semantic units and/or linking units.

As a result of the above described measures, it is possible to introduce into a semantic network - apart from a before/after relation of a semantic network which is changed independently of situation - dynamics which detect a very situation existing in the semantic network, decide about further steps to be performed in dependence on this situation, and perform these steps. There is thus the possibility of demand-oriented operation within the semantic network.

In accordance with the above explanation, the time-variable state of the semantic Janus units constitutes an affect.

In order to elucidate the present invention, it is now explained by referring to Fig. 4 how such an affect and its change may be realized.

Fig. 4 shows a system of coordinates in which various affective conditions are entered.

Affects are generally considered as states in which an individual may find itself. From literature, five fundamental states are known: grief, fear, relaxation, surprise and joy. These fundamental states are representative for an accumulation of similar states such as, e.g., anxiety and frustration.

The system of coordinates represented in Fig. 4 derives from such a view. This system of coordinates may be described as a semantic unit within the semantic network. The coordinates of the system are described in two dimensions. The positive x-axis is designated "gain", the negative x-axis is designated "loss", the positive y-axis is designated "important", and the negative y-axis is designated "unimportant".

There is the possibility of deducting additional coordinates, i.e. sub-coordinates, from each axis of the system of coordinates through further attributes such as, e.g., references to objects, time or space.

The semantic units "affects" may be embedded into the system of coordinates of affects. This means that the semantic units "affects" and the semantic unit "system of coordinates of affects" are linked with each other through linking units of the type including a scale change. Analogously, the semantic units "affects" may be linked with other semantic units "affects" through linking units of the type without scale change. For example a semantic unit "affects" named "in fear" may be linked with the semantic units "affects" named "frustration" or "panic" (neither represented in Fig. 4) through linking units. Moreover, for example, a semantic unit "affects" denominated "acute existential fear" (not shown in Fig. 4) may be a subobject of the semantic unit "in fear" and thus constitute a specialization of the latter, etc. Depending on the situation, this kind of description of affects allows for a rough or detailed description of affects. As

a result of such a description of affects, a semantic Janus unit only focuses on bundled, i.e. rough information. Thus bundled information is used in the processes of pattern recognition, decision-making, and also execution of actions in accordance with the above description.

In utilizing the system of coordinates represented in Fig. 4, the above described rough pattern recognition is thus performed as follows.

Initially there is a search for unusual changes in the informational contents, attributes and/or functions of a semantic unit. This is followed by a search for specific changes, such as for example changes in the informational contents of a particular kind of linking units. After this, the overall state of the semantic unit is roughly classified as, e.g., "good" or "bad". Subsequently classification of the entire state of the semantic unit is performed in connection with the result of the above named search for changes as "important", "unimportant", "gain" and "loss".

"Gain", "loss", "important" and "unimportant" are the designations of the axes of the system of coordinates of affects as represented in Fig. 4. Shifts within the system of coordinates upon a change of the affect, i.e., upon a change of the time-variable state of a semantic Janus unit on the basis of a situation detected in the semantic network may be described with the aid of a set of rules or a model. The layout of such a set of rules or of motion equations of a model may be freely selected by the user in accordance with the purpose of use. For example it is conceivable that an improvement of a situation of a semantic unit may be construed to the effect of the number of vicinity objects having increased. For example this may mean in dependence on a set of rules or a model that a gain results for the overall situation of the semantic

unit and thus a change of the affect of a semantic Janus unit in the direction of the positive x-axis results, i.e. a pleasure gain ensures.

The affects thus constitute evolutionary strategies having the purpose of context-dependent focusing on what is essential. The affects may, for example, be described as semantic units embedded in the system of coordinates of affects which is represented in Fig. 4. Due to the affect, the information about the knowledge concerning the situation in which a semantic unit or a partial network finds itself is bundled to only one point within the system of coordinates of affects, i.e., to the currently existing affect. The current affect, i.e. the present time-variable state, of a semantic Janus unit thus represents bundling via the informational contents and via the vicinity of a semantic unit or of a partial network.

The above described manner of using the affect as a strategy for resource management within semantic networks constitutes an entirely novel concept. The affect and optionally the character of a semantic Janus unit may be utilized for pattern recognition, for decision-making, and for performing actions as well as for perceiving the consequences thereof in both material and immaterial networks. A material network may, for example, be a computer network, an electricity network, a traffic network, a supply network etc. An immaterial network may, for example, be a semantic network within a database, the INTERNET etc. All of these networks may be described as n^{th}-order semantic networks.

The essential advantage of using such resource management in accordance with the above description is the optimum utilization of the available resources such as, e.g., time, by focusing semantic Janus units of semantic units or of a partial network on what is essential.

Besides time, the resources may moreover encompass environment resources, information, knowledge and space.

The following is a description of a further development of the embodiment of the present invention.

Time management of a semantic network may be defined as the perception, generation, administration and fashioning of semantic units with the aid of semantic Janus units within the semantic network over the duration of one or several time segments. Moreover a time segment may be defined according to need, e.g., as a semantic unit or as one of the informational contents of a semantic unit. A time segment may comprise one or several time units as informational contents. For example, one time segment may last one hour of calculation time.

Time is accordingly recorded as a semantic unit. In this sense the semantic Janus units may with the aid of selective time segmentation form, sort out, classify, reposition, delete semantic time units, newly generate them from a combination or from an interaction of other ones (emergence), create connections between them (association, memory functions, learning) or incorporate them into their algorithms such that the latter may form new ones by simulation and expectation (prediction).

Each time segment is formed within a semantic network as a semantic unit. The different duration of the time segments in the vicinity of the semantic time unit is subject to principles of evolutionary selection, i.e., memory functions.

Semantic units within the semantic network may relate to past and/or presence and/or future.

Semantic Janus units may within a virtual semantic network perceived by them virtually reposition, recombine,

newly generate, change, delete, replace semantic units and thereby calculate expectations, make predictions, find a new identity etc. Hereby a so-called "simulation within the simulation" becomes possible. This means that the semantic Janus units may possess or newly generate algorithms and/or methods, further develop them, and operate with them in a world of ideas, i.e. in a semantic network of ideas or notions just like in real network. According to need each semantic Janus unit may create within itself, i.e. within the said semantic Janus unit, an image of a partial network and operate on it just as if the image were indeed existing in the network (thought processes).

In order to detect long-term and short-term changes of informational contents of semantic units or of partial networks such as, e.g., of attributes, functions, algorithms, memorize them in the semantic network, put them in a relation to each other, remember them (memory function), form temporal patterns from them or recognize them, a semantic unit "temporal object" may be defined which contains as an informational content the state of a semantic unit, of a partial network or of the entire network at a time segment. With the aid of corresponding memory functions, the semantic Janus unit can generate temporal objects (time segmentation), replace, delete or arrange them in the network, search or recognize them.

One possible application of the present invention lies, for example, with geometrical structures such as graphic objects having associations among each other. These graphic objects thus constitute semantic units which are linked through linking units. When the above explained procedures are applied, it is, for example, possible to change shapes and/or colors of the graphic objects as a function of a respective existing situation. Here it is advantageous to use vector graphics.

This method may in one application also be used for generating, changing and/or deleting specific semantic units, so-called view units, which have the purpose of graphically or textually representing the existing semantic network, hereinafter referred to as model, to one or several users.

The internal state of the Janus unit generating these view units may both be pre-defined and changed by the user(s). A semantic model unit included by this Janus unit shall presently be referred to as a "central object". Thus the user may, for example, specify that view units are to be generated exclusively for those semantic model units which are located in a given vicinity of the "central object" and may be reached through given types of association. The user may also interactively carry out a selection and change while the program is running.

In this way a user may concentrate or focus on those sets of problems that are of interest to him.

Further possible applications of the present invention are, for example, the management of supply or disposal networks, robot-networked or agent-networked systems, automation in the field of man-machine communication, pattern recognition, simulation, management of on-line help for computer programs, application in the multi-media field or film industry, controlling a hardware network inside a computer or networking computers, decision-making and pattern recognition in the stock market, on the market or in politics, automatic piloting of vehicles, of production networks within a company, for example by means of simulation, applications in the medical field such as the management of supply networks of hospitals or clinics, management of the communication between physician and patient (e.g., the patient has at his home medical monitoring equipment which is linked through a computer with a corresponding physician's computer), application in

on-line monitoring of patients in the intensive care unit or in the operating theater, application in facility management or risk management or organization of learning in the network.

Atty. Docket No. 03400.P012

Claims

1. A semantic network comprised of a multiplicity of units, wherein said semantic network contains both semantic units (6) possessing relational contents and also linking units (1a to 4c) describing a relational content which links two respective semantic units (6) such that the mutual relation of the two linked semantic units (6) is determined by the relational content, wherein:

at least some of said semantic units (6) are specific semantic Janus units (5) which are also linked with other semantic units (6) through linking units (1 to 4c);

the said semantic Janus units (5) are capable of carrying out operations on themselves, on semantic units (6) to which they are linked and/or on those to which these are in turn directly or indirectly linked and/or on the linking units (1 to 4c) of the said mentioned semantic units (6), and the said semantic Janus units (5) possess time-variable states,

characterized in that:

said time-variable states determine what operations are to be carried out on what semantic units (6) and/or linking units (1a to 4c), and

values of informational contents of said semantic units (6) and/or linking units (1 to 4c) changed as a result of the operations of said semantic Janus units (5) are set, new informational contents or new types of informational contents and/or new semantic units and/or linking units (1a to 4c) and/or partial networks are introduced and/or semantic units (6) and/or linking units (1a to 4c) and/or partial networks within said semantic network are changed or deleted.

2. A semantic network in accordance with claim 1, *characterized in that* the time-variable states of the semantic Janus units (5) express a respective situation existing in said semantic network, in dependence on which operating within said semantic network is carried out, wherein focusing on selected parts of said semantic network takes place.

3. A semantic network in accordance with claim 1, characterized in that said semantic Janus units (5) have both a vicinity to be monitored, which is monitored by said semantic Janus units (5), and a vicinity to be shaped on which said semantic Janus units (5) perform operations, and a respective new time-variable state of said semantic Janus units (5) is determined from the existing time-variable state of said semantic Janus units (5) and/or from an analysis of an optionally variable vicinity to be monitored.

4. A semantic network in accordance with claim 3, *characterized in that* said vicinity to be monitored and/or said vicinity to be shaped are formed of a subset of a vicinity of semantic units (6) to which a respective semantic Janus unit (5) is linked, and/or of a subset of a vicinity of the very respective semantic Janus unit (5).

5. A semantic network in accordance with any one of claims 1 through 4, *characterized in that* said semantic Janus units (5), dependently on the existing time-variable state, only concentrate on superobjects located on a higher scale, subobjects located on a lower scale, and/or adjacent objects located on a same scale of said semantic units (6) to which they are

linked, and/or on said semantic Janus units (5) themselves.

6. A semantic network in accordance with claim 5, characterized in that said linking units (1a to 4c) are also incorporated with said superobjects, subobjects and/or adjacent objects.

7. A semantic network in accordance with any one of claims 1 through 6, characterized in that said semantic Janus units (5) furthermore possess evaluation criteria indicating what informational contents of semantic units (6), what semantic units (6), or what partial networks are to be treated next; what priorities are set in a semantic unit (6), in a partial network, or in said entire semantic network; in what manner time-variable states of semantic Janus units (5) are to be deducted from the states of semantic units (6), of partial networks of said semantic network, or of said entire semantic network; how rapidly time-variable states of semantic Janus units (5) change; and/or in what manner semantic units (6) and/or linking units (1a to 4c) are treated.

8. A semantic network in accordance with claim 7, *characterized in that* said evaluation criteria are subject to temporal changes which change only slightly with respect to the time-variable states of said semantic Janus units (5).

9. A semantic network in accordance with any one of claims 1 to 8, characterized in that said semantic units (6) are equally capable of changing or deleting their own informational contents or linking units (1a to 4c) and/or generating new informational contents and/or linking units (1a to 4c) or deleting themselves.

10. A semantic network in accordance with any one of claims 1 to 9, *characterized in that* said semantic Janus units (5) may also be linked with other semantic Janus units (5) and/or linking units (1a to 4c) through linking units (1a to 4c) and are capable of carrying out operations on these.

11. A semantic network in accordance with any one of claims 1 to 10, *characterized in that* said time-variable state of semantic Janus units (5) is defined with the aid of points plotted in a two-dimensional system of coordinates.

12. A semantic network in accordance with claim 11, *characterized in that* said time-variable state is shifted with the aid of a set of rules or of motion equations of a model, whereby a new time-variable state is thus defined.

13. A semantic network in accordance with any one of claims 1 to 12, *characterized in that* at least parts of said semantic units (6) are graphic objects linked among each other through linking units (1a to 4c).

14. A semantic network in accordance with claim 13, characterized in that shapes and/or colors of respective graphic objects are changed depending on respective existing, time-variable states of semantic Janus units (5).

15. A semantic network in accordance with claim 13 or 14, characterized in that vector graphics are used.

16. A semantic network in accordance with any one of claims 13 to 15, *characterized in that* semantic Janus units (5) may within a virtual semantic network

perceived by them virtually reposition, recombine, newly generate, change, delete, replace semantic units (6) and thereby calculate expectations, make predictions and/or find a new identity.

17. A semantic network in accordance with claim 16, *characterized in that* said semantic Janus units (5) may possess or newly generate algorithms and/or methods, further develop them, and operate with them in a virtual environment just like in real semantic networks, each semantic Janus unit (5) being capable of creating in itself, according to need, an image of a partial network and operating on the latter just as if said image were indeed existing in said semantic network.

18. Semantic network in accordance with any one of claims 3 to 17, *characterized in that* the time-variable state of a semantic Janus unit (5) and/or the selection of the vicinity to be monitored and/or the vicinity to be shaped may interactively be changed by a user or by users.

19. A semantic network in accordance with claim 18, *characterized in that* a semantic Janus unit (5) generates, deletes and/or changes semantic view units that present semantic model units of the vicinity to be monitored to the user(s).

PCT

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Internationales Büro

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(54) Title: SITUATION–DEPENDENT OPERATING SEMANTIC N–ORDER NETWORK

(54) Bezeichnung: SITUATIONSABHÄNGIG OPERIERENDES SEMANTISCHES NETZ N–TER ORDNUNG

(57) Abstract

Disclosed is a semantic network consisting of a plurality of units, wherein the semantic network comprises semantic units having a relational content and associative units describing a relational content and associating two semantic units in such a way that mutual relationship between the associated semantic units is determined by the relational content. At least some semantic units in said network are special semantic Janus units which are also associated with other semantic units by associative units. Furthermore, said semantic Janus units can carry out operations within themselves, in the semantic units with which they are associated and/or in those units with which they are directly or indirectly associated and/or in the associative units of said semantic units. Said semantic Janus units have states that are variable in time that determine which operations should be carried out in which semantic units and/or associative units.

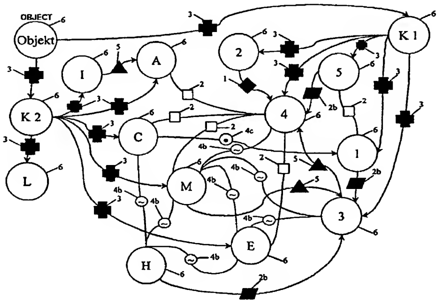


Fig. 1a

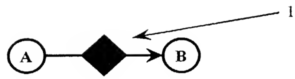


Fig. 1b

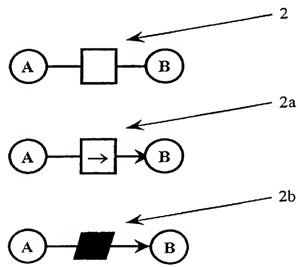


Fig. 1c

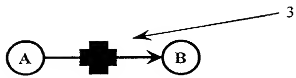


Fig. 1d

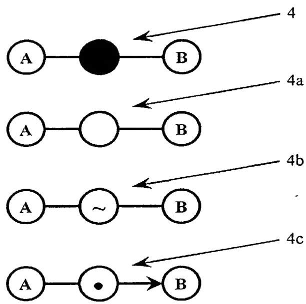
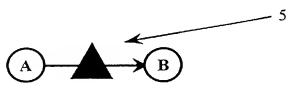


Fig. 1e



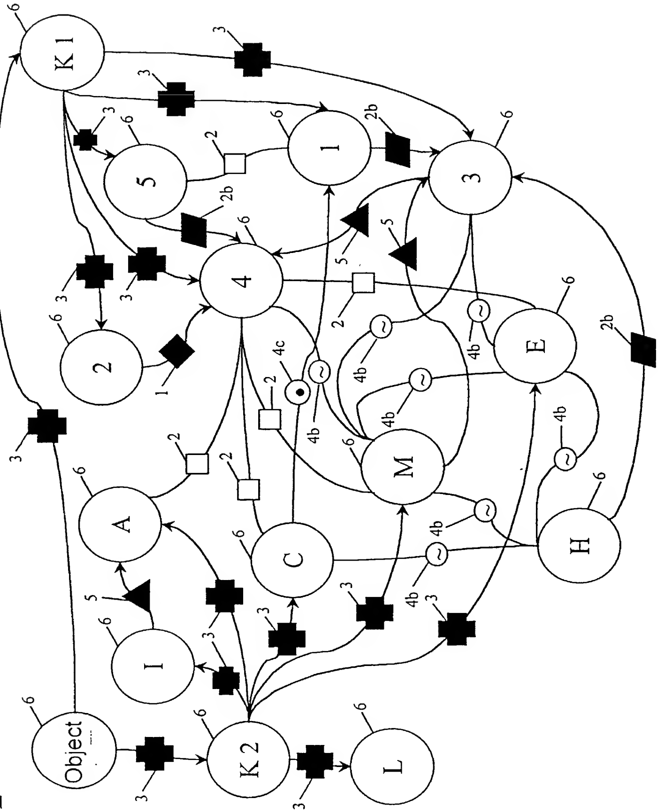
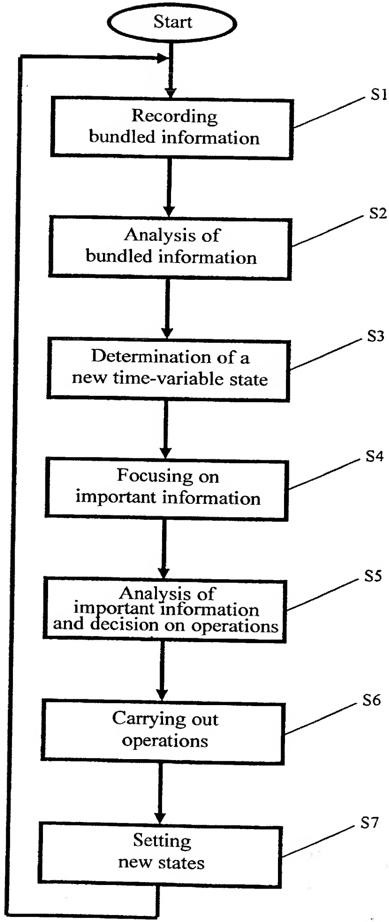


Fig. 2

Fig. 3


Start
Recording bundled information
S1
Analysis of bundled information
S2
Determination of a new time-variable state
S3
Focusing on important information
S4
Analysis of important information and decision on operations
S5
Carrying out operations
S6
Setting new states
S7

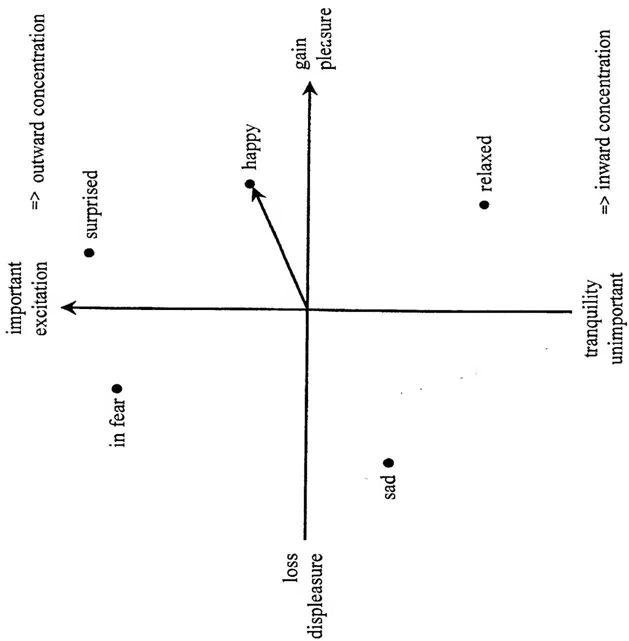

gain
pleasure
loss
displeasure
important
excitation
tranquility
unimportant
=> outward concentration
=> inward concentration
surprised
happy
relaxed
in fear
sad

Fig. 4

Attorney's Docket No.: 3400P012

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or any original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Nth -ORDER SEMANTIC NETWORK ALLOWING FOR SITUATION-DEPENDANT OPERATION

the specification of which

☐ is attached hereto.
☒ was filed on **April 18, 2000** as
United States Application Number ______
or PCT International Application Number **PCT/EP00/03540**
and was amended on ______.
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application. I do not know and do not believe that the claimed invention was in public use or on sale in the United States of America more than one year prior to this application, nor do I know or believe that the invention has been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):

APPLICATION NUMBER	COUNTRY (OR INDICATE IF PCT)	DATE OF FILING (day, **month**, year)	PRIORITY CLAIMED
DE 19917592.6	German	April 19, 1999	☐ No ☒ Yes
			☐ No ☐ Yes
			☐ No ☐ Yes

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below:

APPLICATION NUMBER	FILING DATE

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

APPLICATION NUMBER	FILING DATE	STATUS (ISSUED, PENDING, ABANDONED)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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